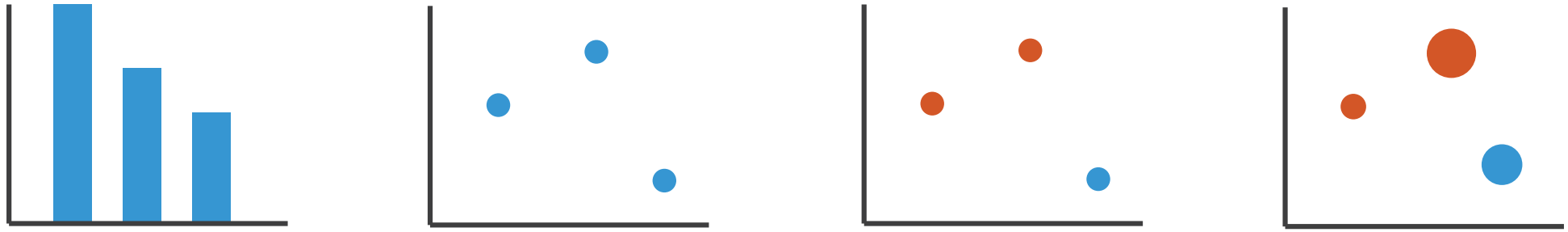
Marks and Channels

Visual Encoding

- how to systematically analyze idiom structure?



- marks & channels
  - marks: represent items or links
  - channels: change appearance of marks based on attributes

Marks for Items

- Basic geometric elements

Points

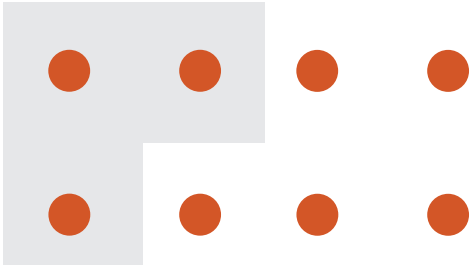
Lines

Areas

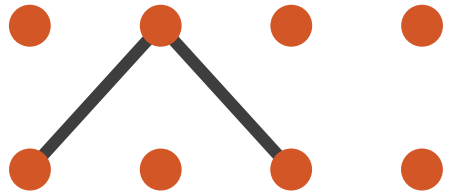
- 3D mark, volume, *rarely* used

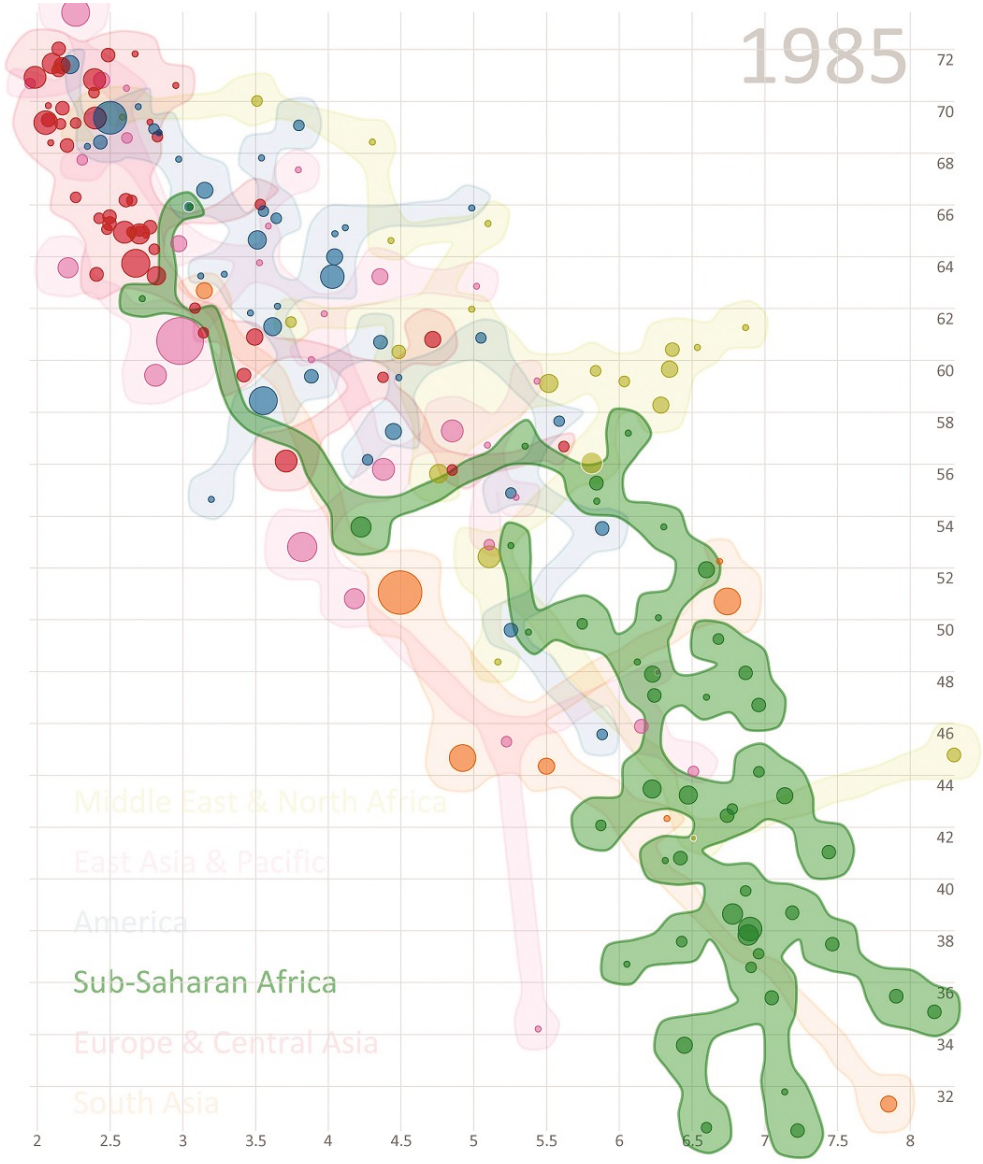
Marks for Links

Containment



Connection




1985
72
70
68
66
64
62
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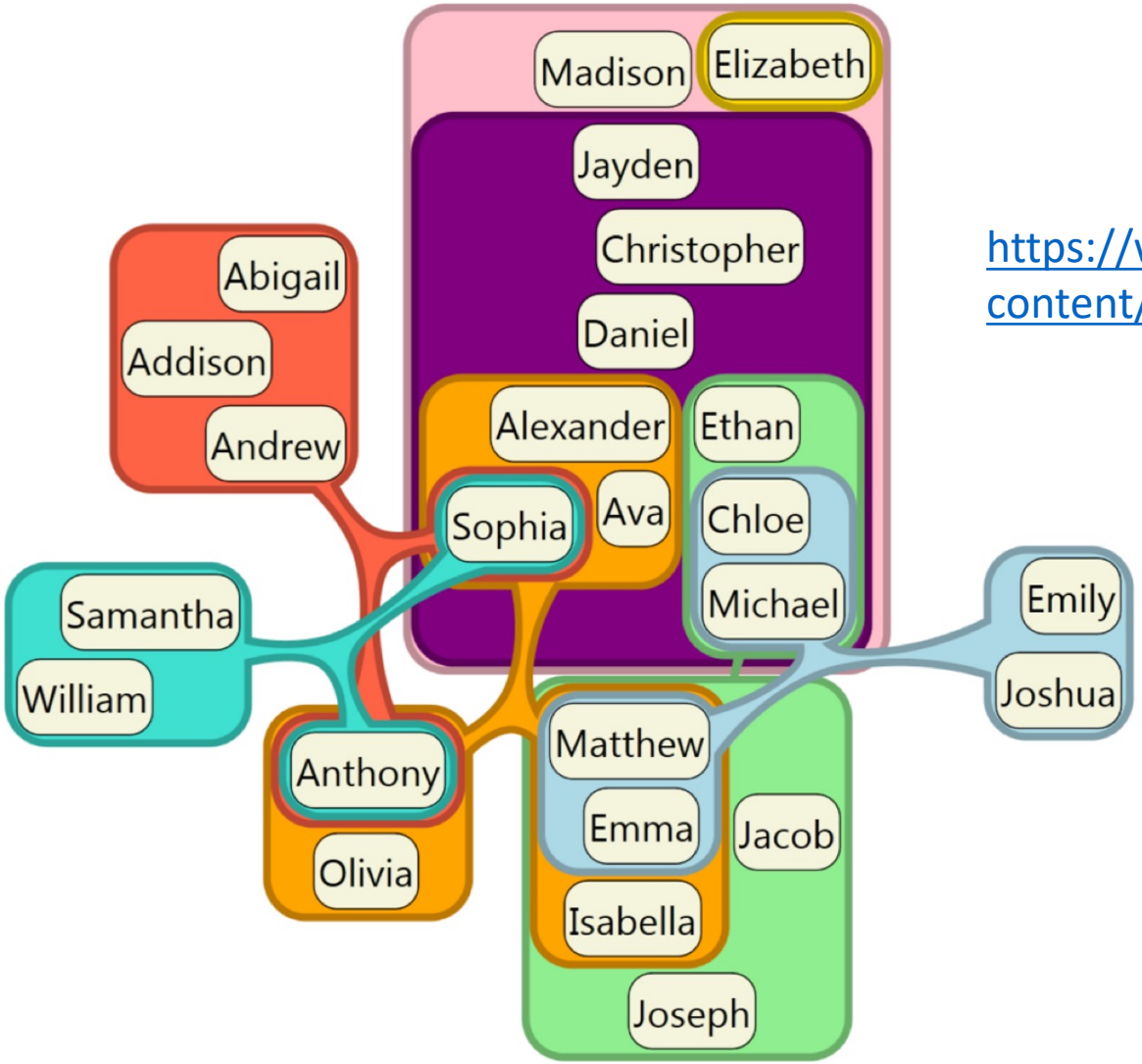
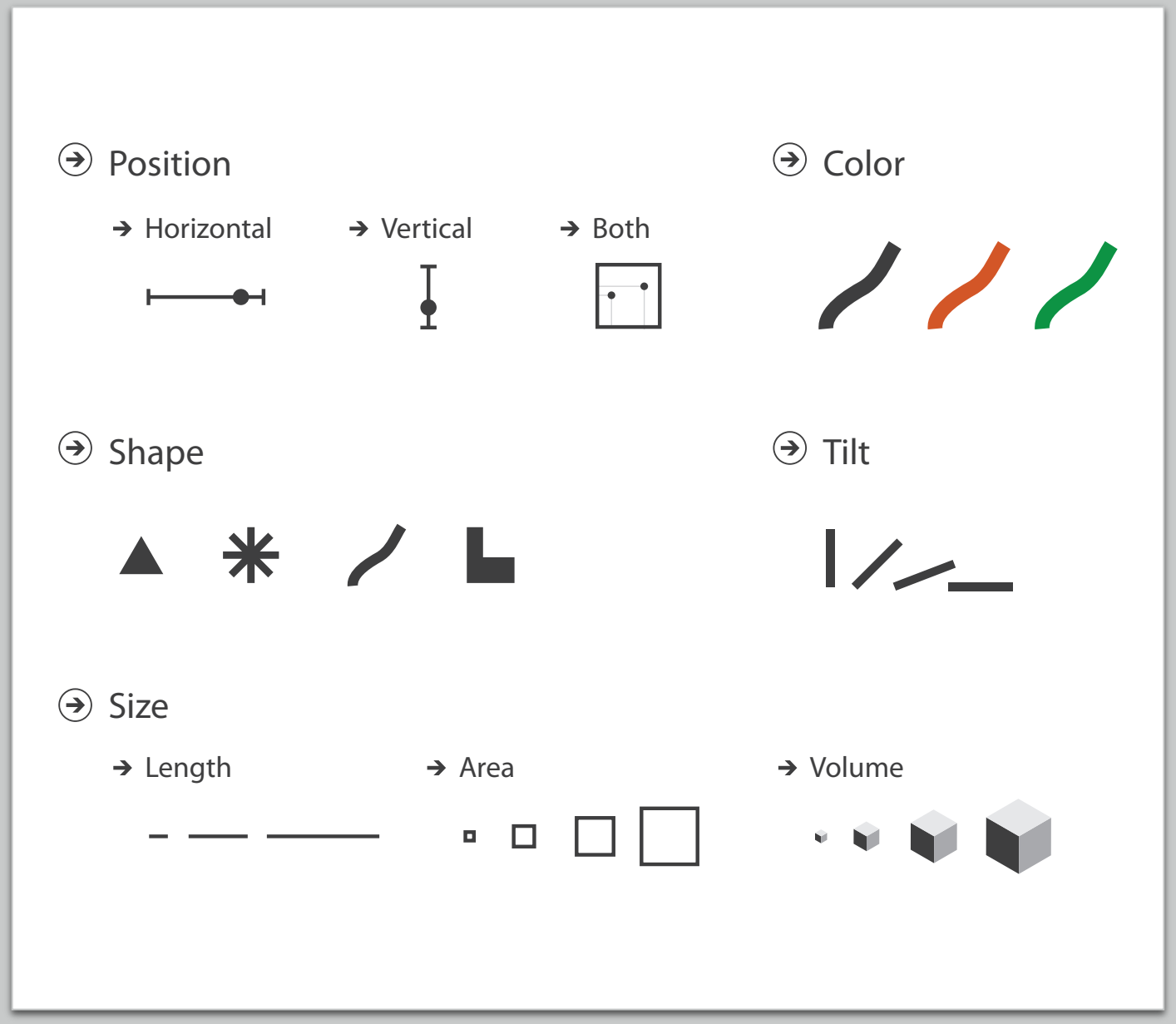
56
54
52
50
48
46
44
42
40
38
36
34
32
Middle East & North Africa
East Asia & Pacific
America
Sub-Saharan Africa
Europe & Central Asia
South Asia
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8

Containment can be Nested



https://www.microsoft.com/en-us/research/wp-content/uploads/2016/12/eulerdiagrams_infovis2010.pdf

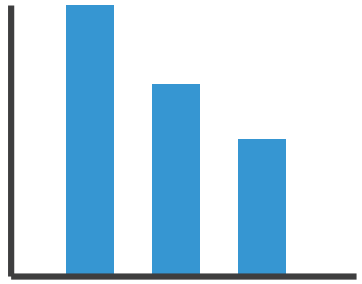


Channels

- control appearance of marks
  - proportional to or based on attributes
- many names
  - **visual channels**
  - visual variables
  - retinal channels
  - visual dimensions

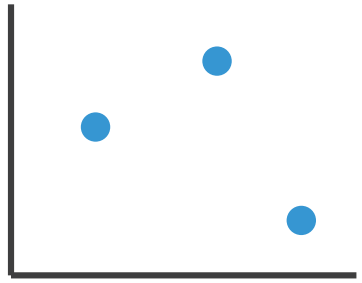
Visual Encoding

- analyze idiom structure
  - as combination of marks and channels



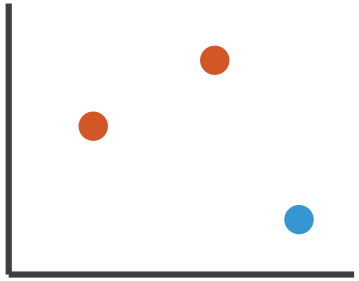
1:
vertical position

mark: line



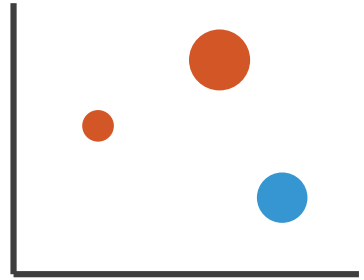
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

mark: point

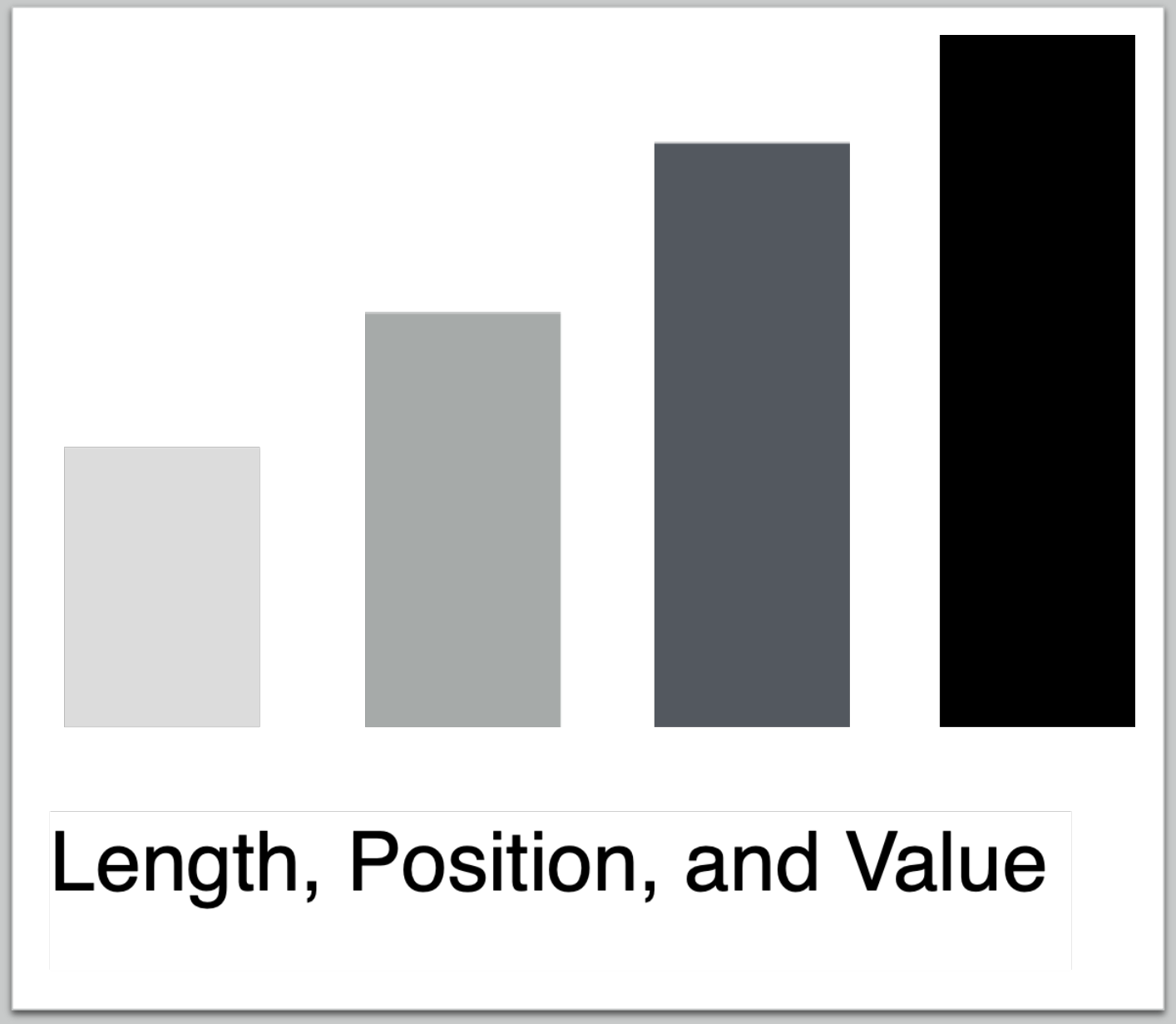


4:
vertical position
horizontal position
color hue
size (area)

mark: point

Redundant Encoding

- multiple channels
  - sends stronger message
  - but uses up channels



Spot the Problem

https://twitter.com/ChaseThomason/status/1118478036507164672

When to use which channel?

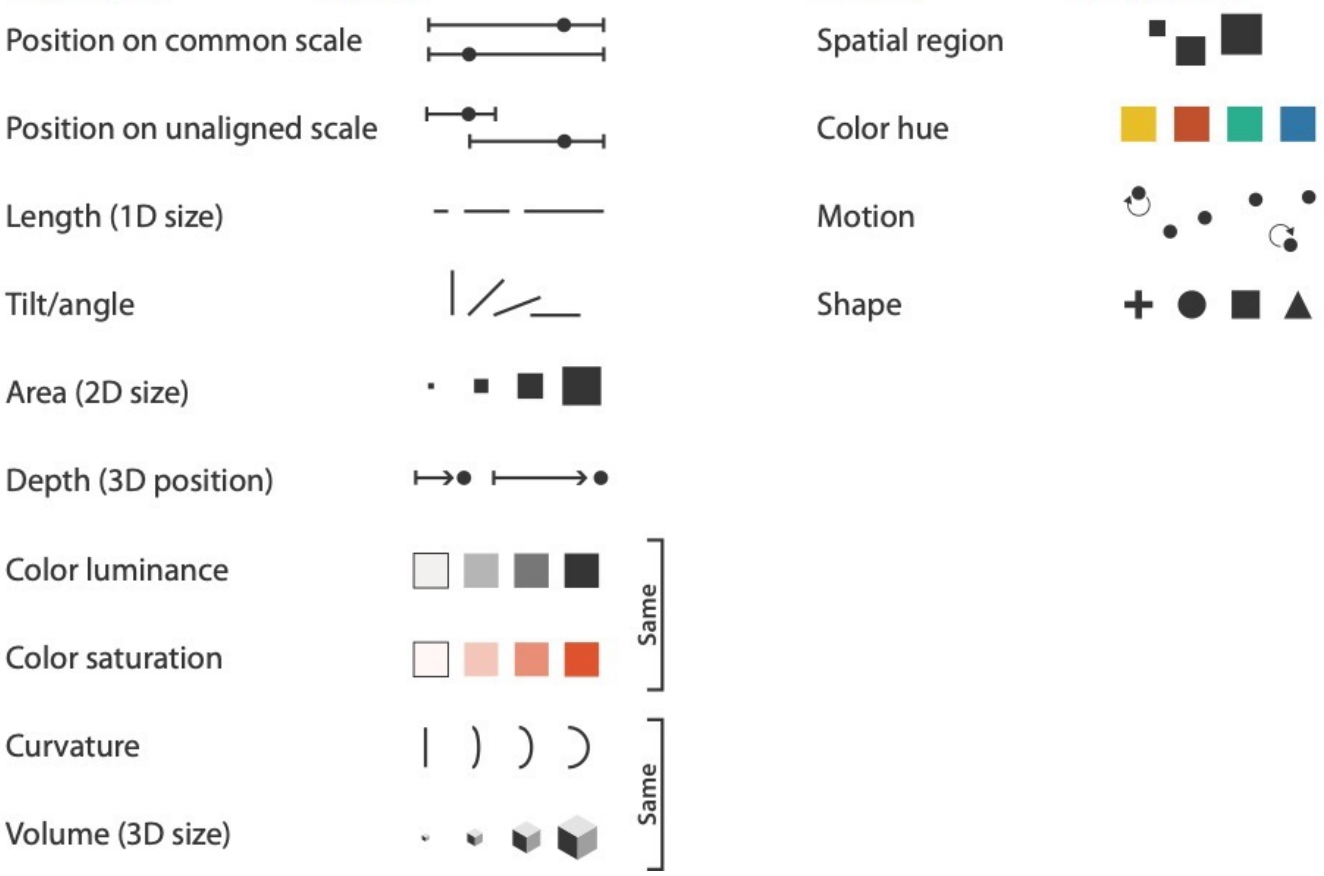
expressiveness

match channel type to data type

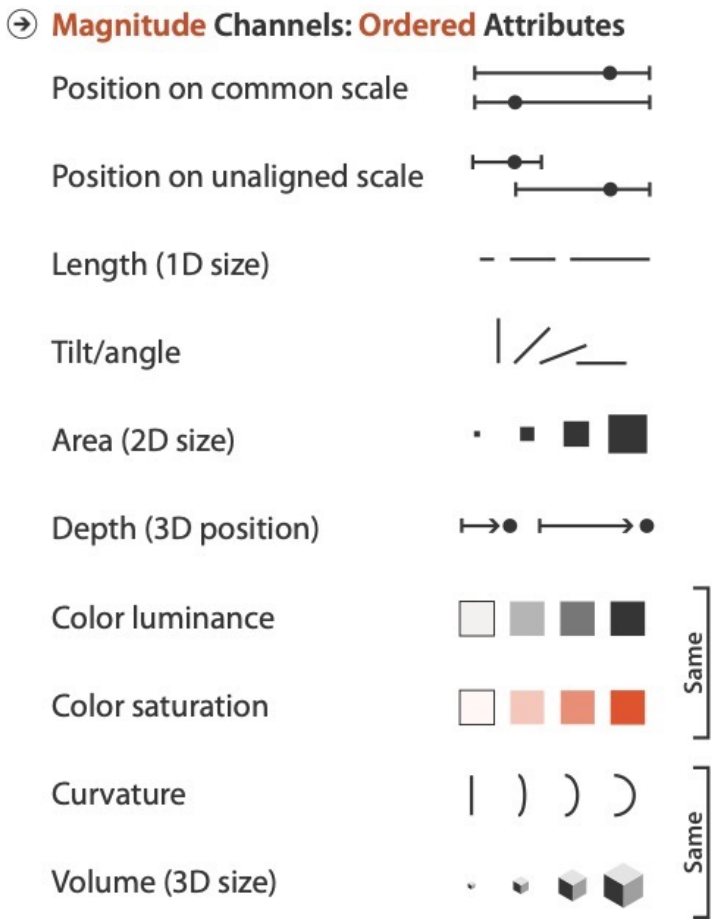
effectiveness

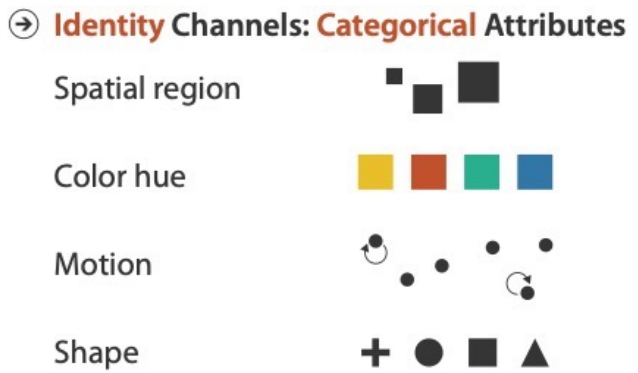
some channels are better than others

Channels


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
Spatial region
Color hue
Motion
Shape

Channels : Matching Types

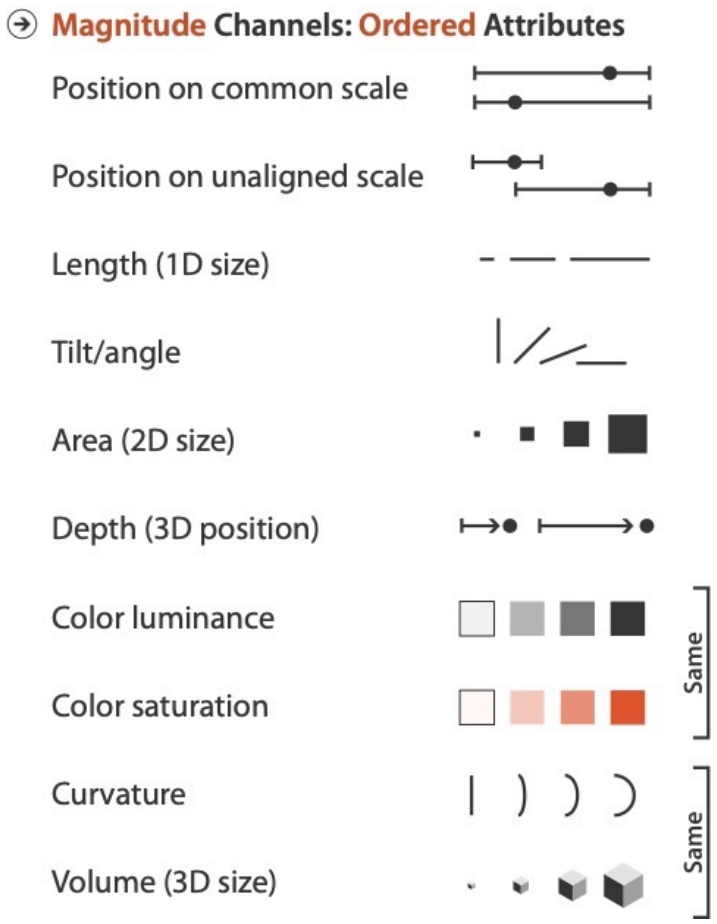


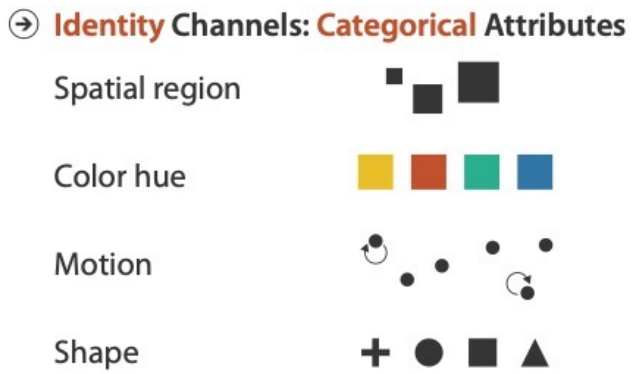


expressiveness principle

- match channel and data characteristics
  - magnitude for ordered
    - how much? which rank?
  - identity for categorical
    - what?

Channels : Matching Types

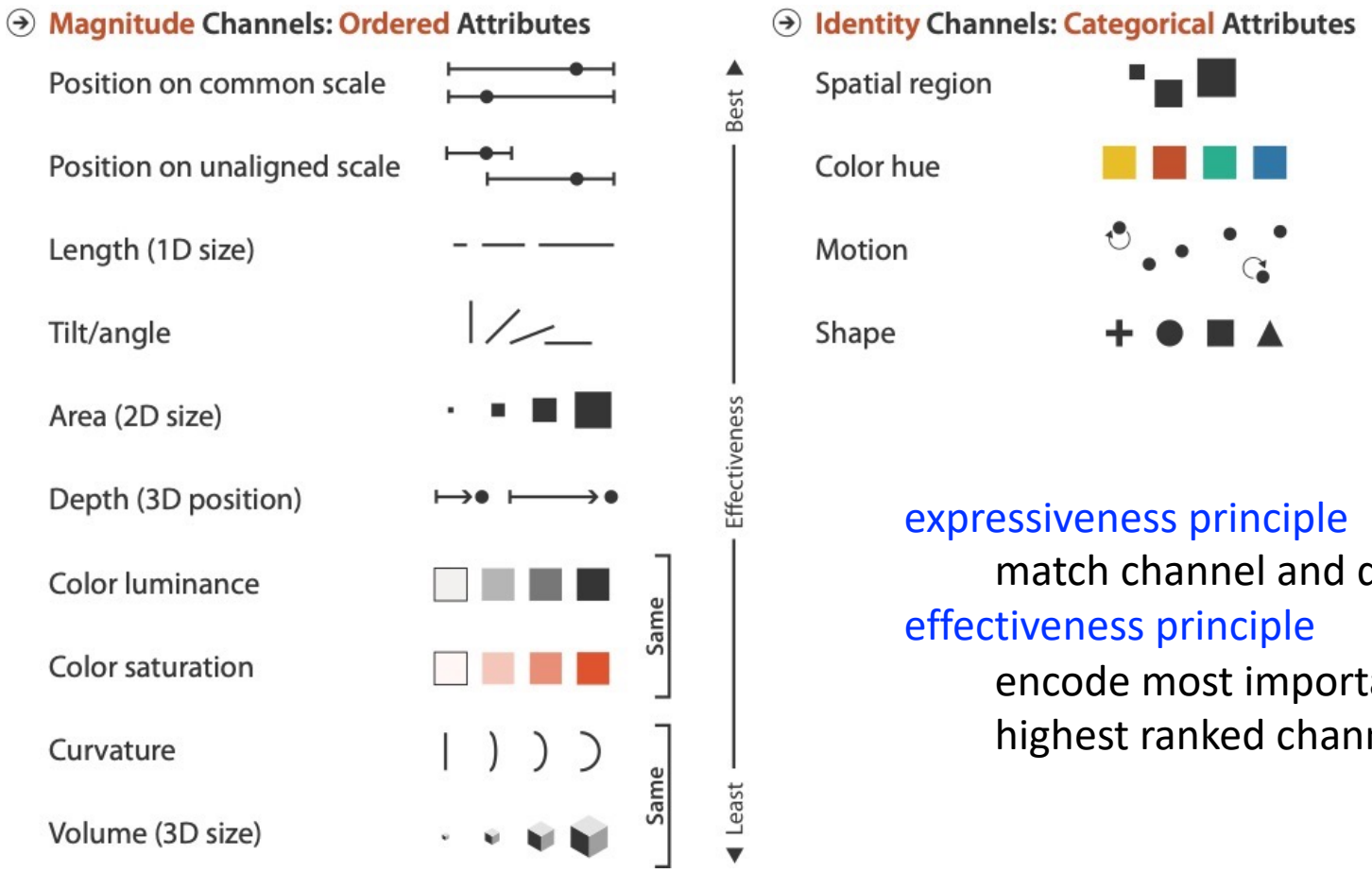




expressiveness principle

- match channel and data characteristics
  - magnitude for ordered
    - how much? which rank?
  - identity for categorical
    - what?

Channels : Rankings



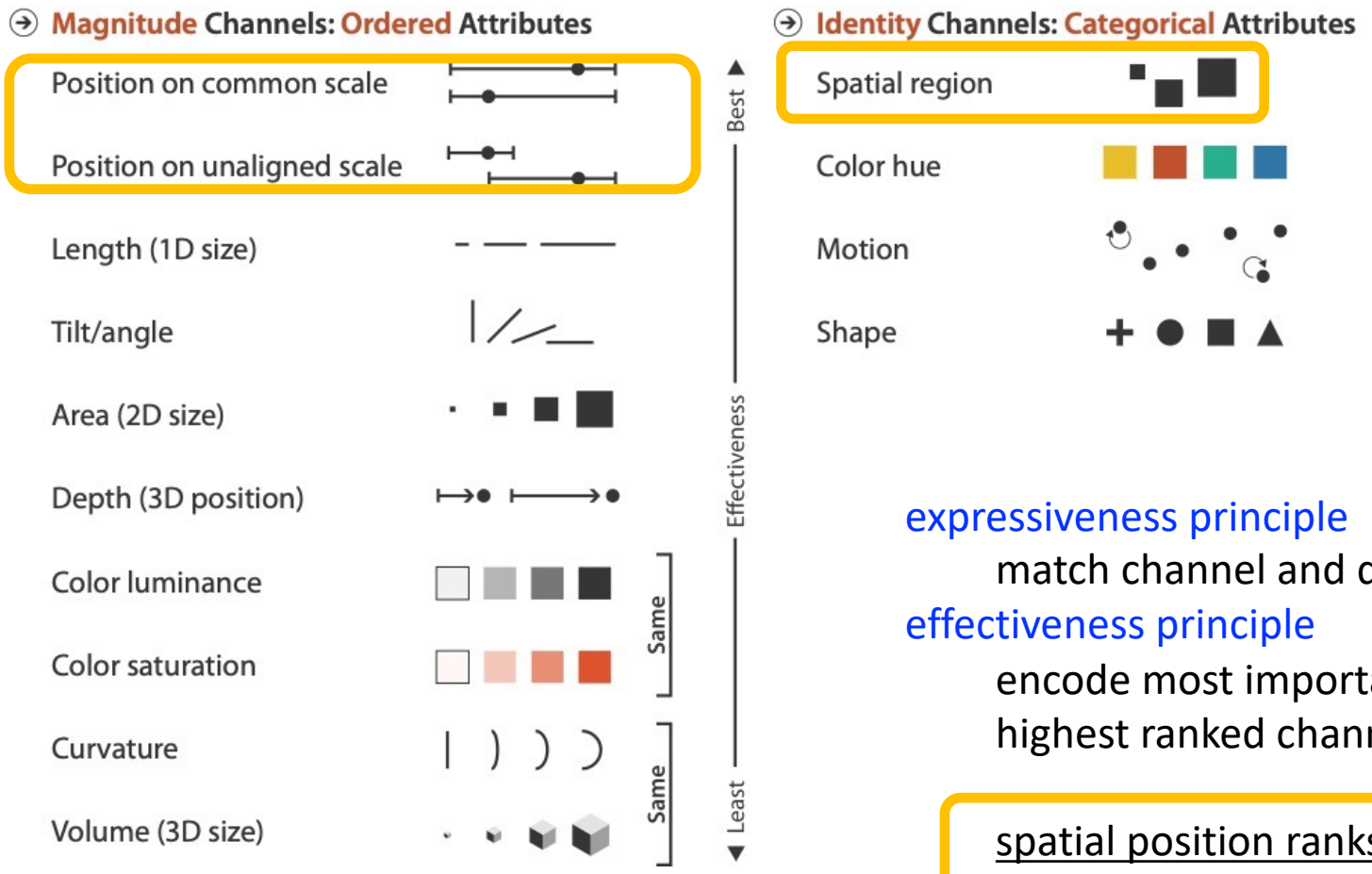
expressiveness principle

match channel and data characteristics

effectiveness principle

encode most important attributes with highest ranked channels

Channels : Rankings



expressiveness principle

match channel and data characteristics

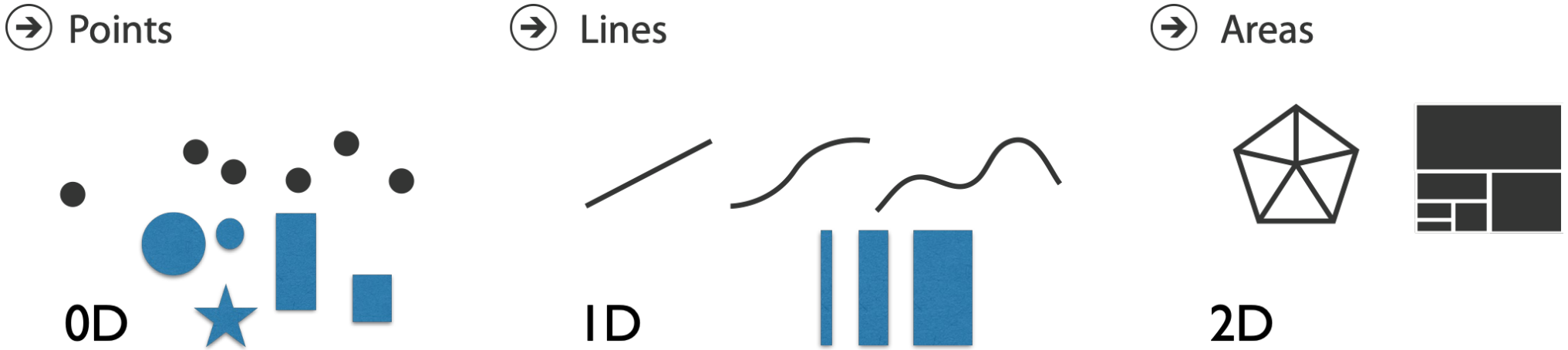
effectiveness principle

encode most important attributes with highest ranked channels

spatial position ranks high for both

Marks: Constrained vs Encodable

- math view: geometric primitives have dimensions



- constraint view: mark type constrains what else can be encoded
  - points: 0 constraints on size, can encode more attributes w/ size & shape
  - lines: 1 constraint on size (length), can still size code other way (width)
  - areas: 2 constraints on size (length/width), cannot use size code or shape code

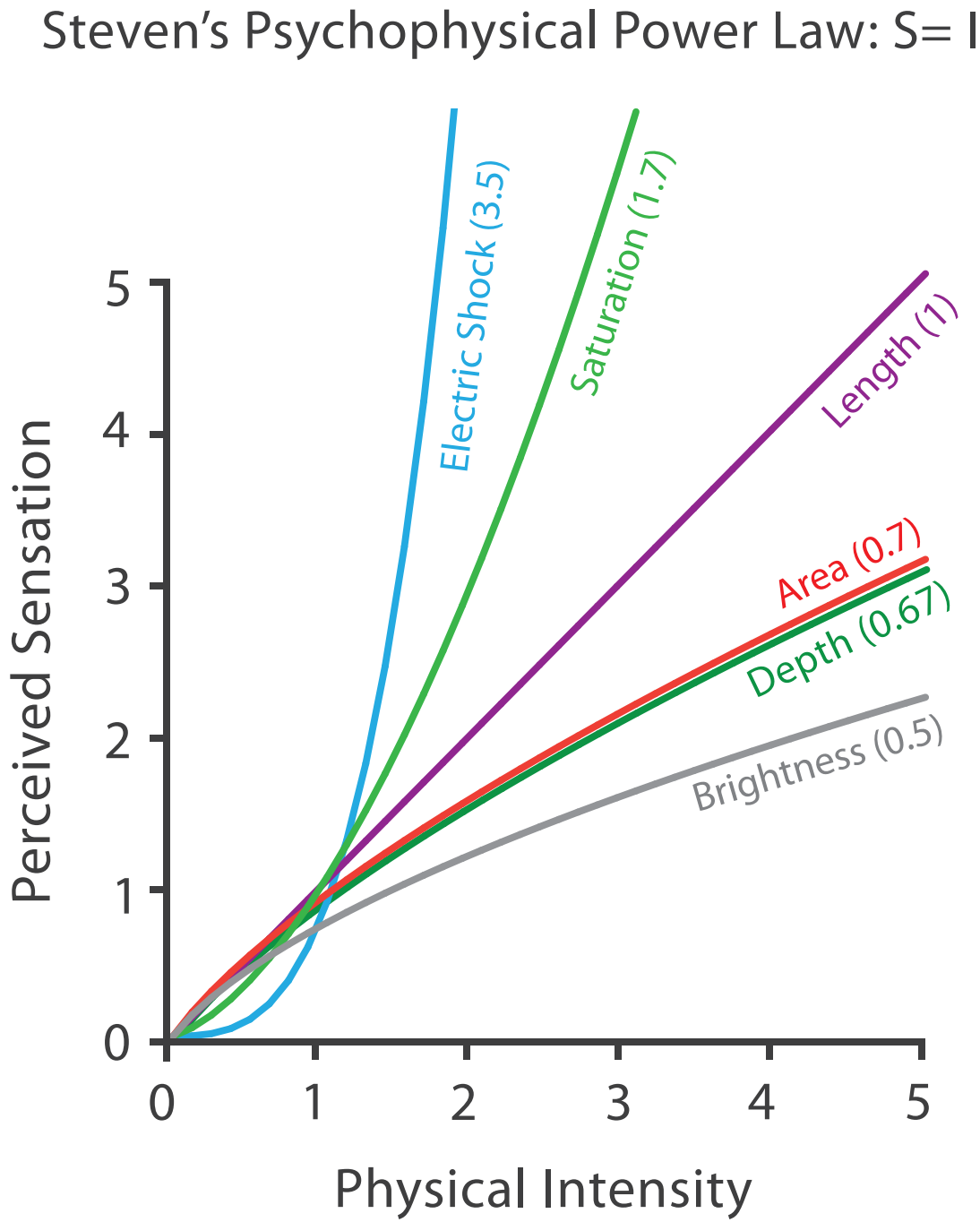
Channel Effectiveness

- Accuracy:
  - how precisely can we tell the difference between encoded items?
- Discriminability:
  - how many unique steps can we perceive?
- Separability:
  - is our ability to use this channel affected by another one?
- Popout:
  - can things jump out using this channel?

Accuracy: Fundamental Theory

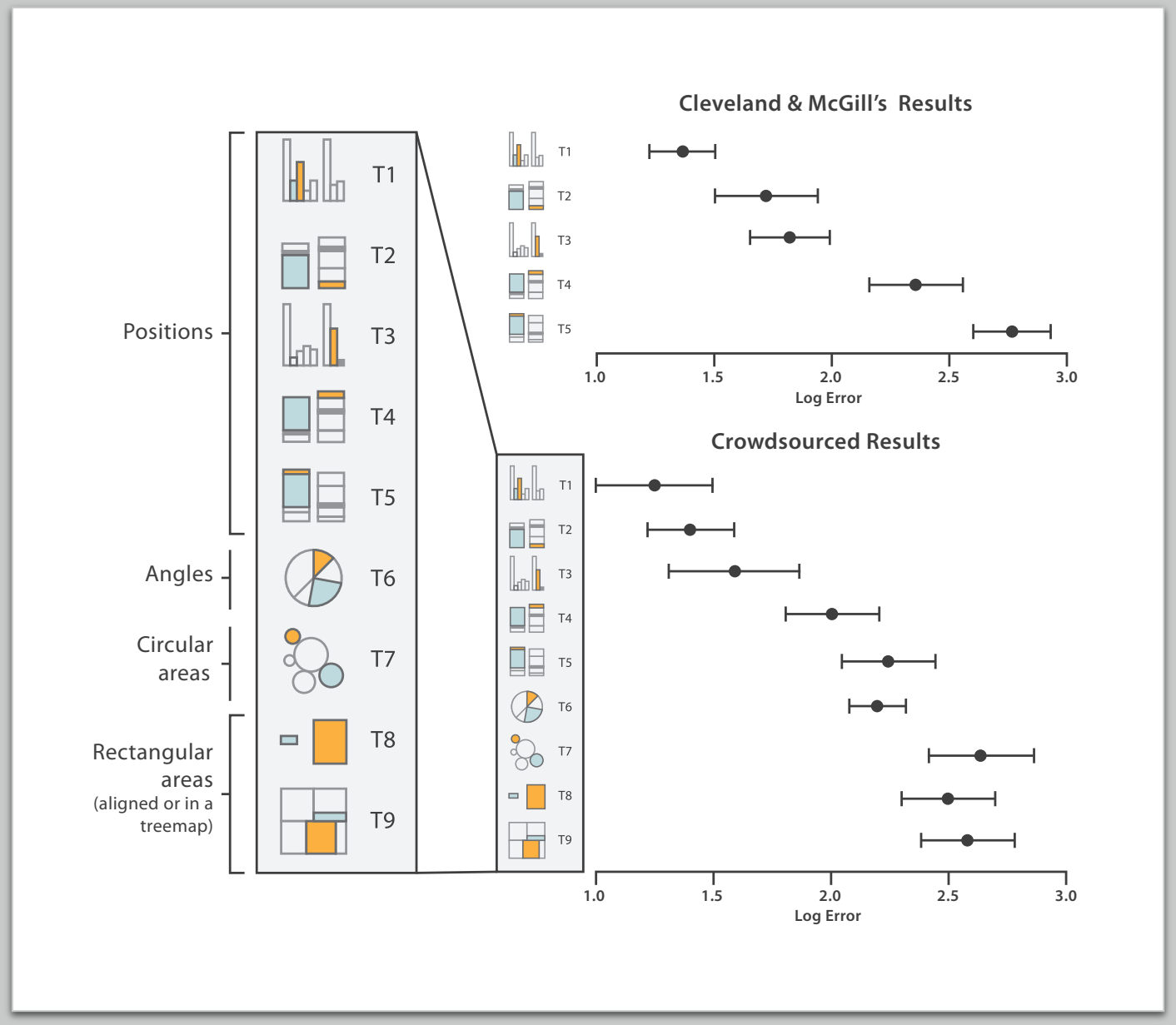
- length is accurate: linear
- others magnified or compressed
  - exponent characterizes

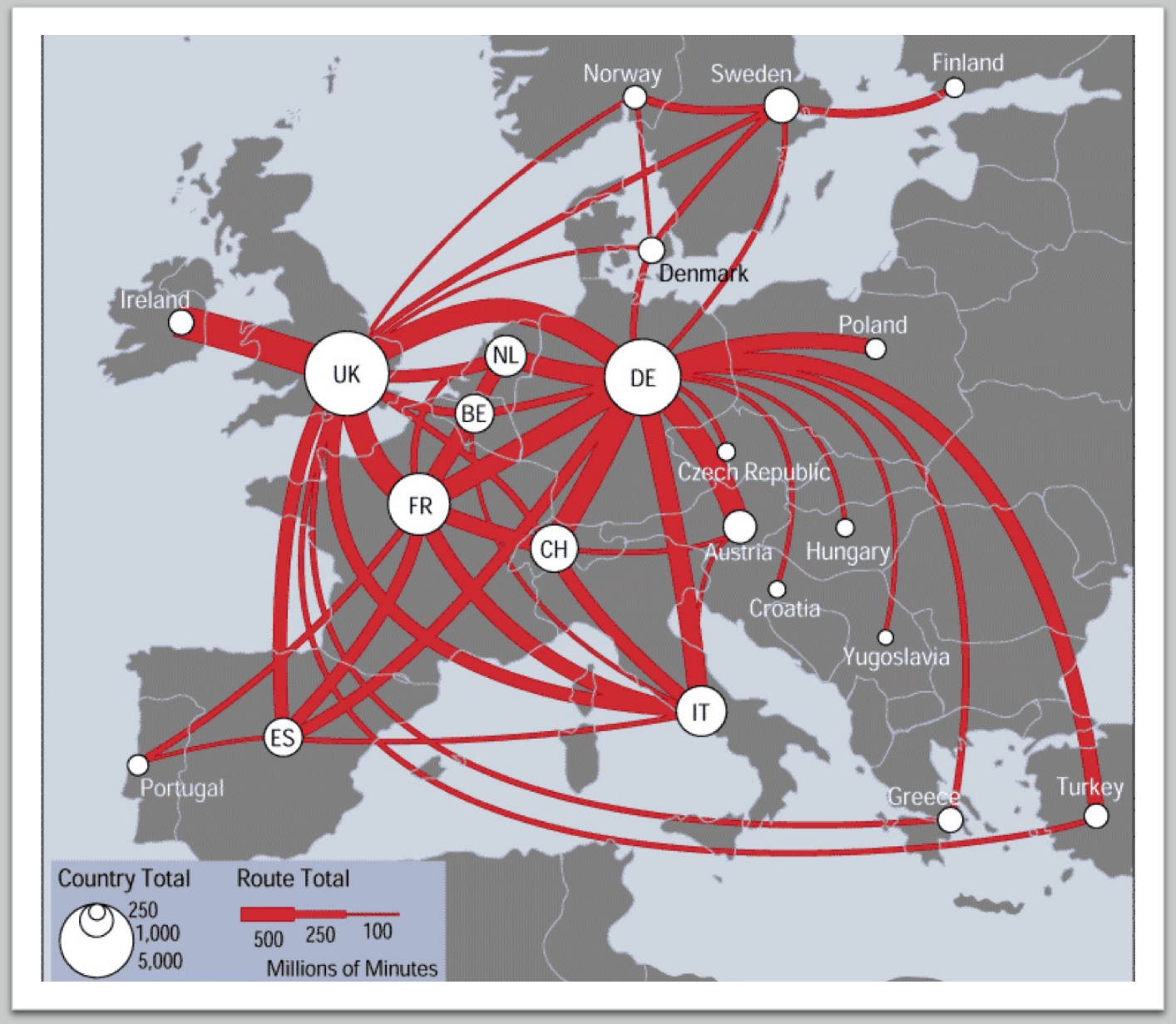
- S = sensation
- I = intensity



Accuracy: Visualization Experiments

- *[Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design. Heer and Bostock. Proc ACM Conf. Human Factors in Computing Systems (CHI) 2010, p. 203–212.]*



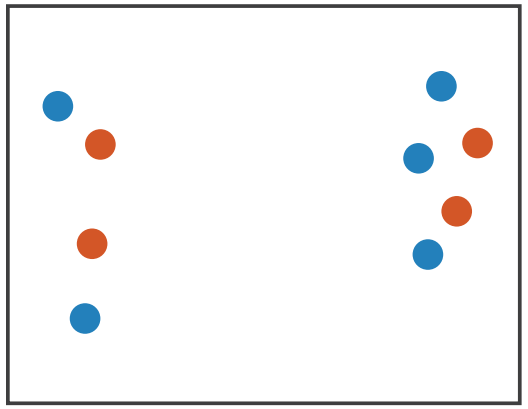


Discriminability: How many usable steps?

- must be sufficient for number of attribute levels to show
  - linewidth: few bins but salient

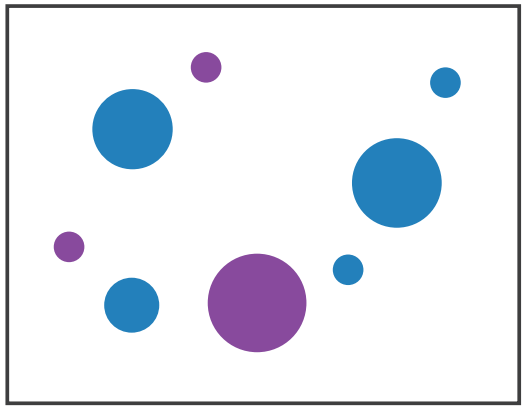
Separability vs. Integrality

Position
+ Hue (Color)



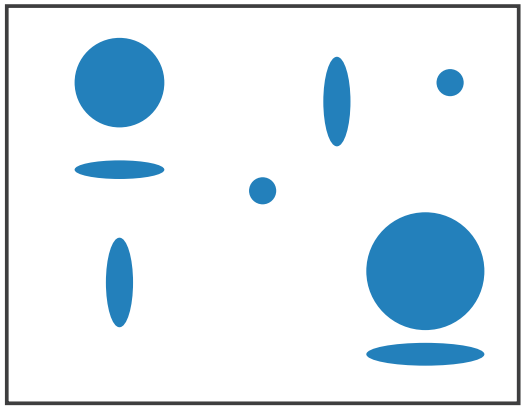
Fully separable

Size
+ Hue (Color)



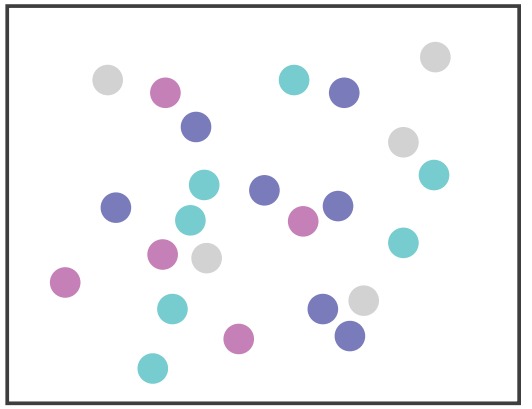
Some interference

Width
+ Height



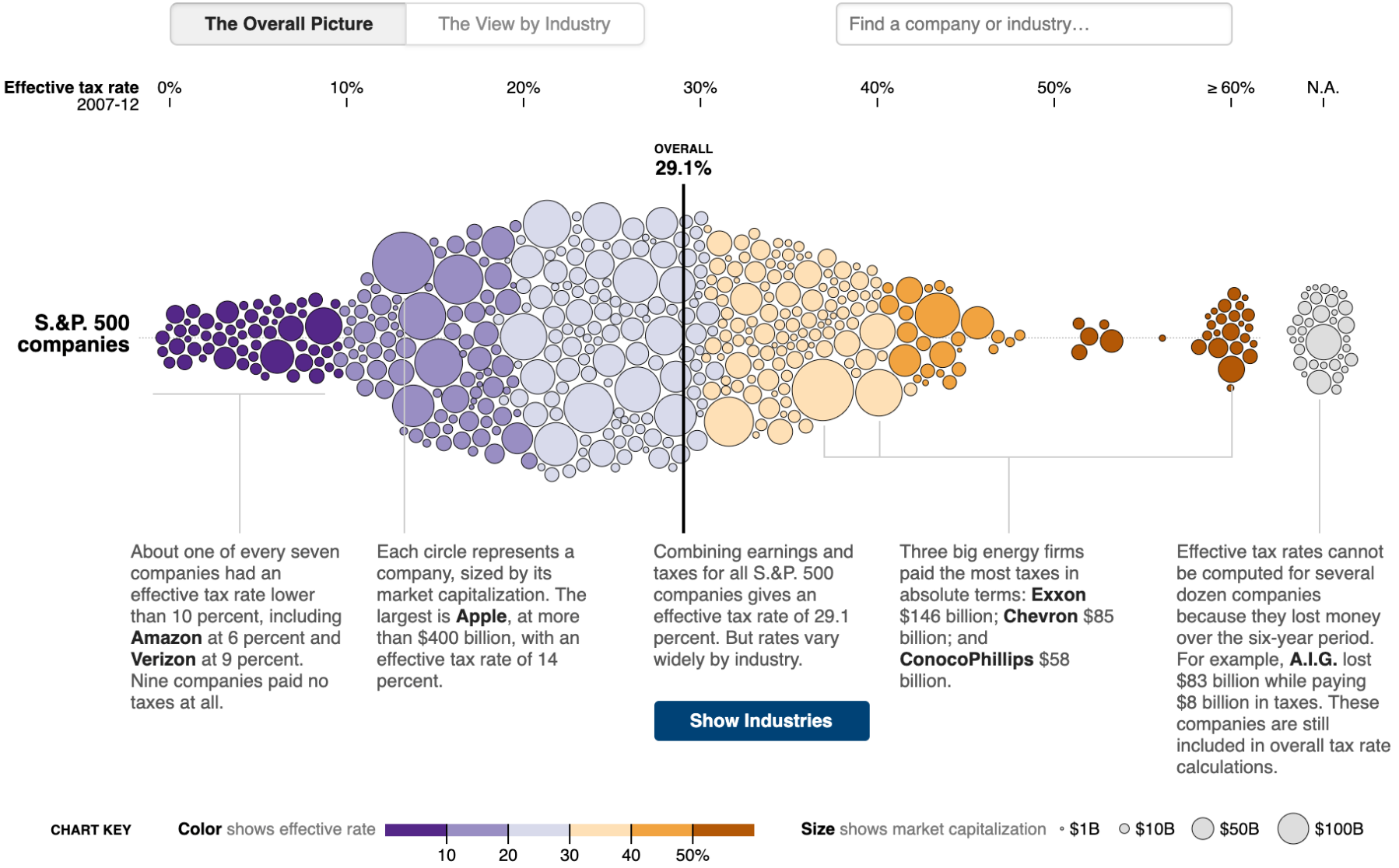
Some/significant interference

Red
+ Green



Major interference

Group Discussion: Marks / Channel?



https://archive.nytimes.com/www.nytimes.com/interactive/2013/05/25/sunday-review/corporate-taxes.html