CS49000-VIZ - Fall 2020

Introduction to Data Visualization

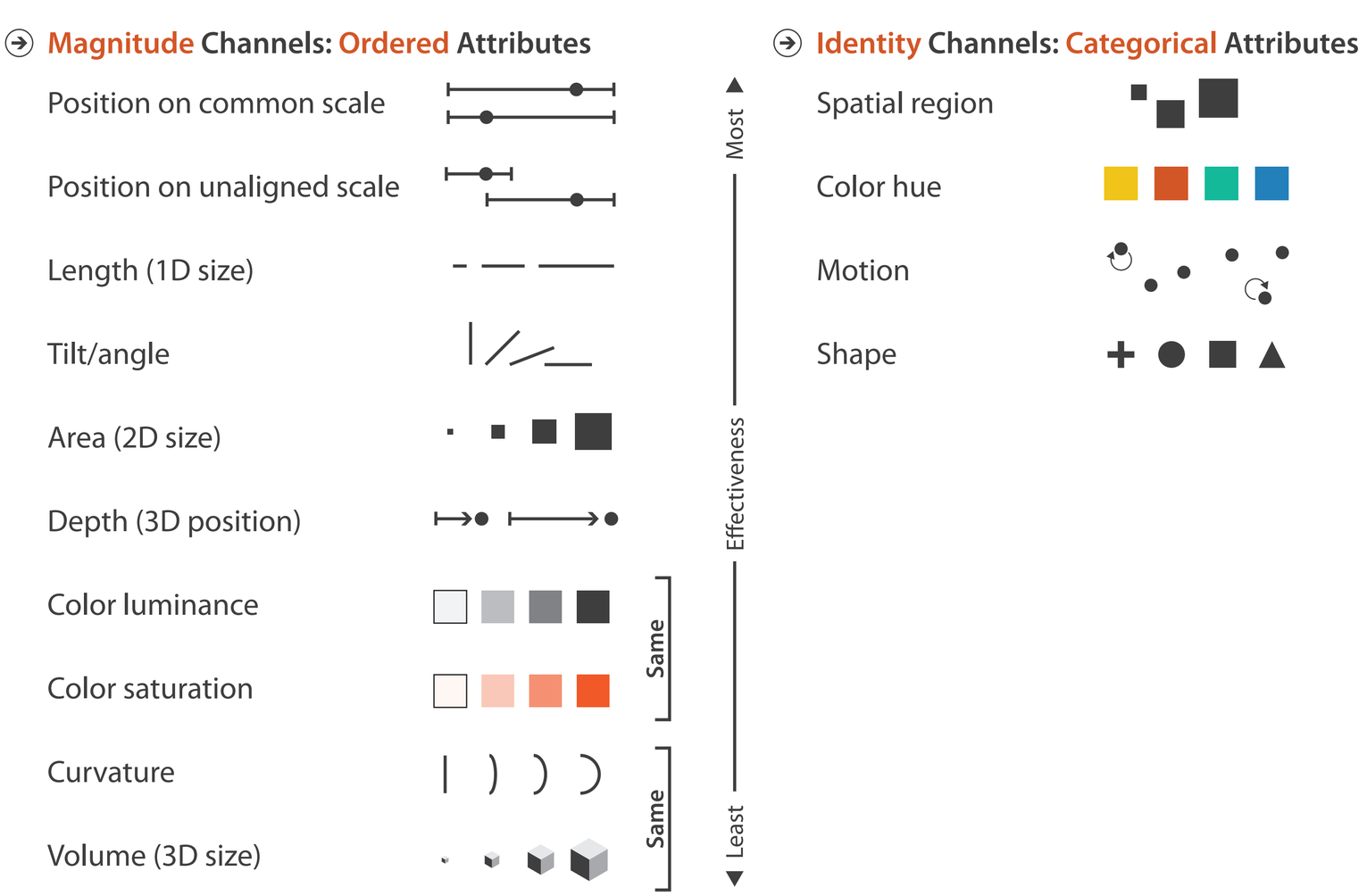
Marks and Channels

Lecture 5

September 7, 2020

Ch 5: Marks and Channels

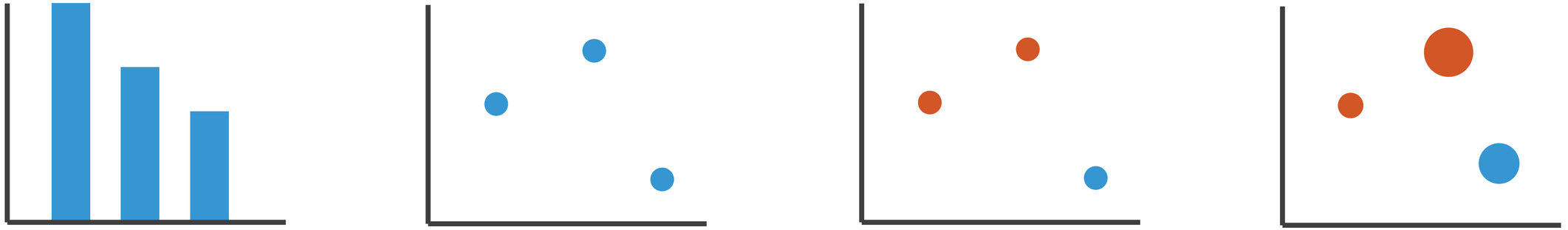
Channels: Expressiveness Types and Effectiveness Ranks



[VAD Fig 5.1]

Encoding visually

- analyze idiom structure

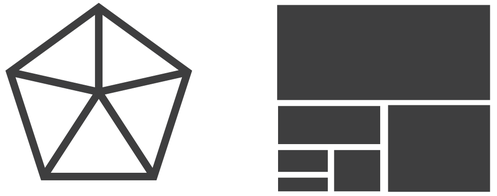


Definitions

- Points

- Lines

- Areas



Definitions

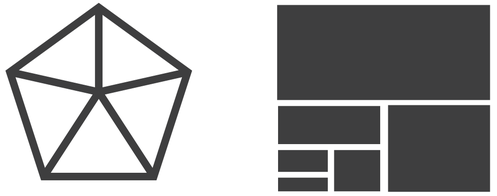
Marks:

geometric primitives

- Points

- Lines

- Areas

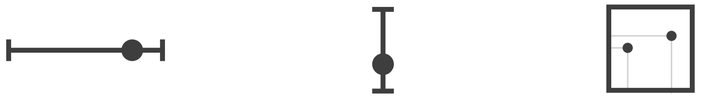


Definitions

Channels

control appearance of marks

- Position
  - Horizontal
  - Vertical
  - Both

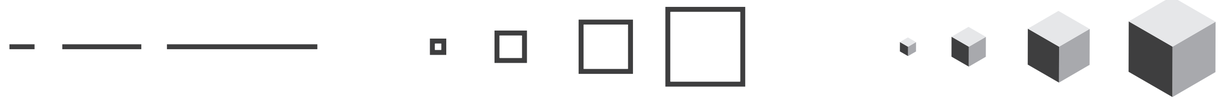


- Color

- Shape

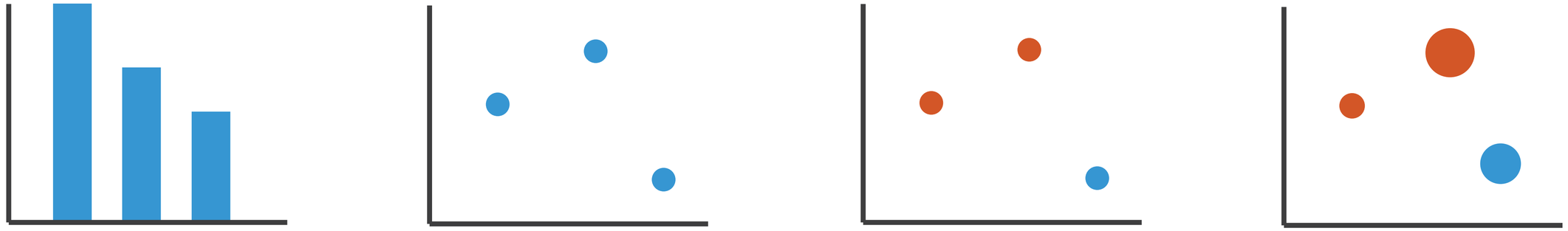
- Tilt

- Size
  - Length
  - Area
  - Volume



Using marks and channels

- analyze idiom structure
  - as combination of marks and channels



Using marks and channels

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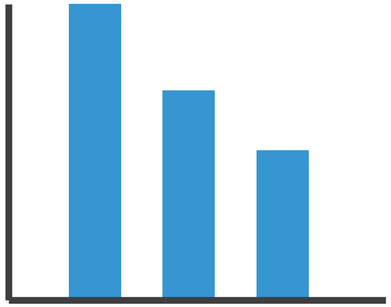
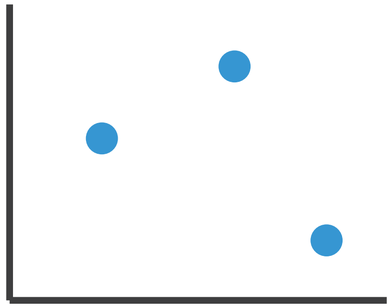
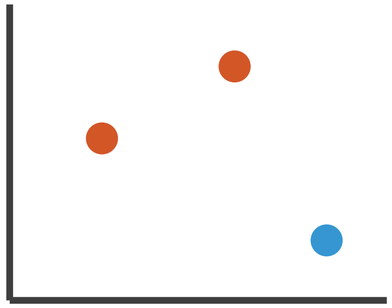
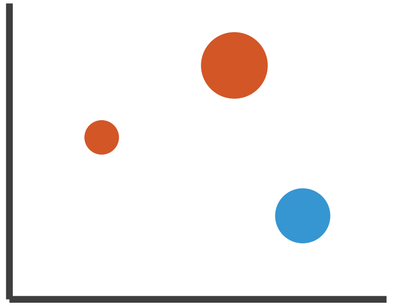






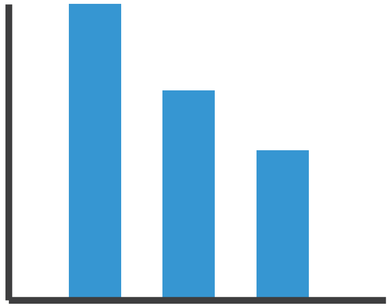


1:
vertical position

mark: line

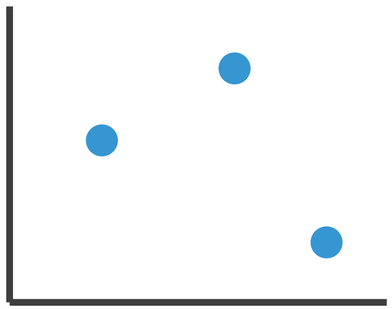
Using marks and channels

- analyze idiom structure
  - as combination of marks and channels



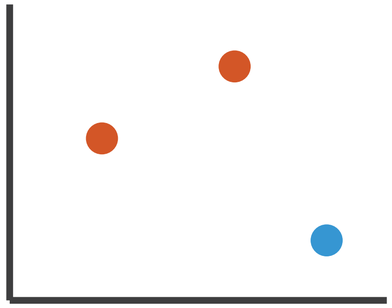
1:
vertical position

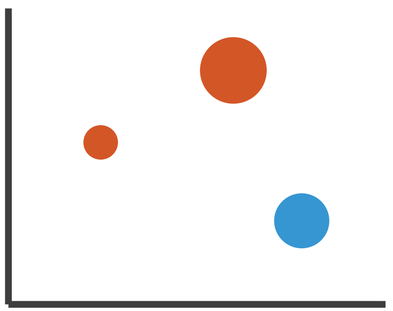
mark: line



2:
vertical position
horizontal position

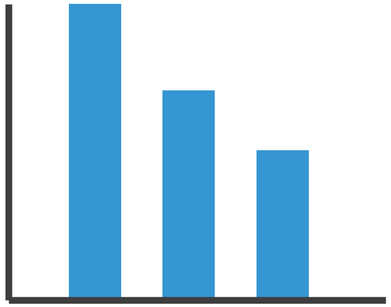
mark: point





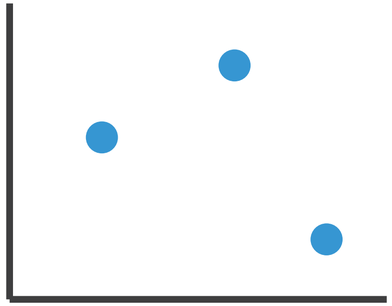
Using marks and channels

- analyze idiom structure
  - as combination of marks and channels



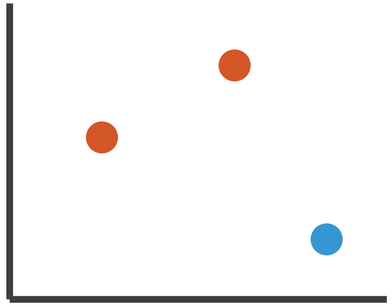
1:
vertical position

mark: line



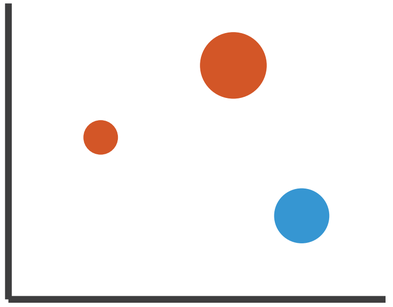
2:
vertical position
horizontal position

mark: point



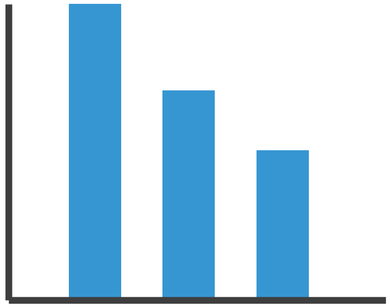
3:
vertical position
horizontal position
color hue

mark: point



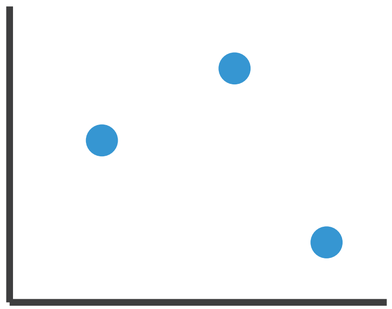
Using marks and channels

- analyze idiom structure
  - as combination of marks and channels



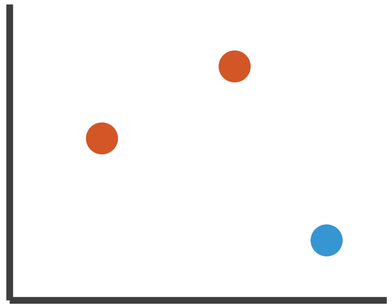
1:
vertical position

mark: line



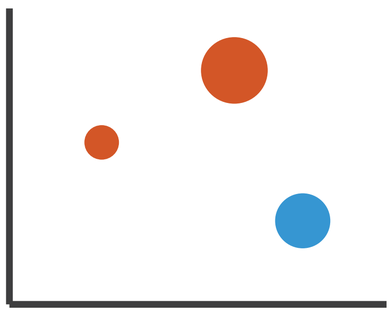
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

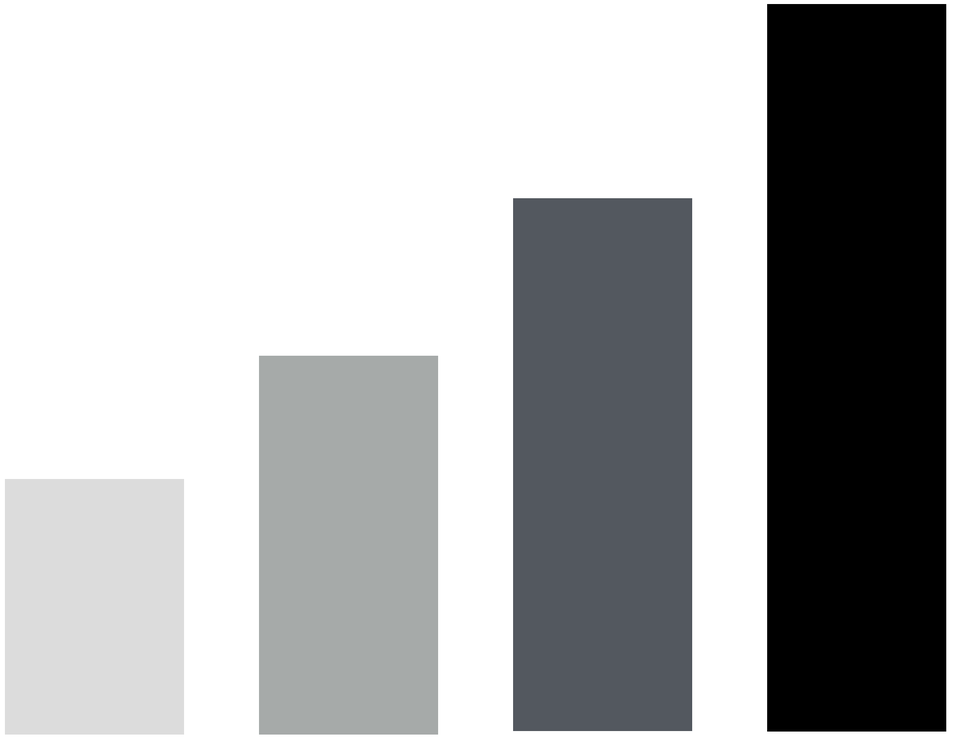
mark: point



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

mark: point

Redundant Encoding



Length, position, and value

Channels

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

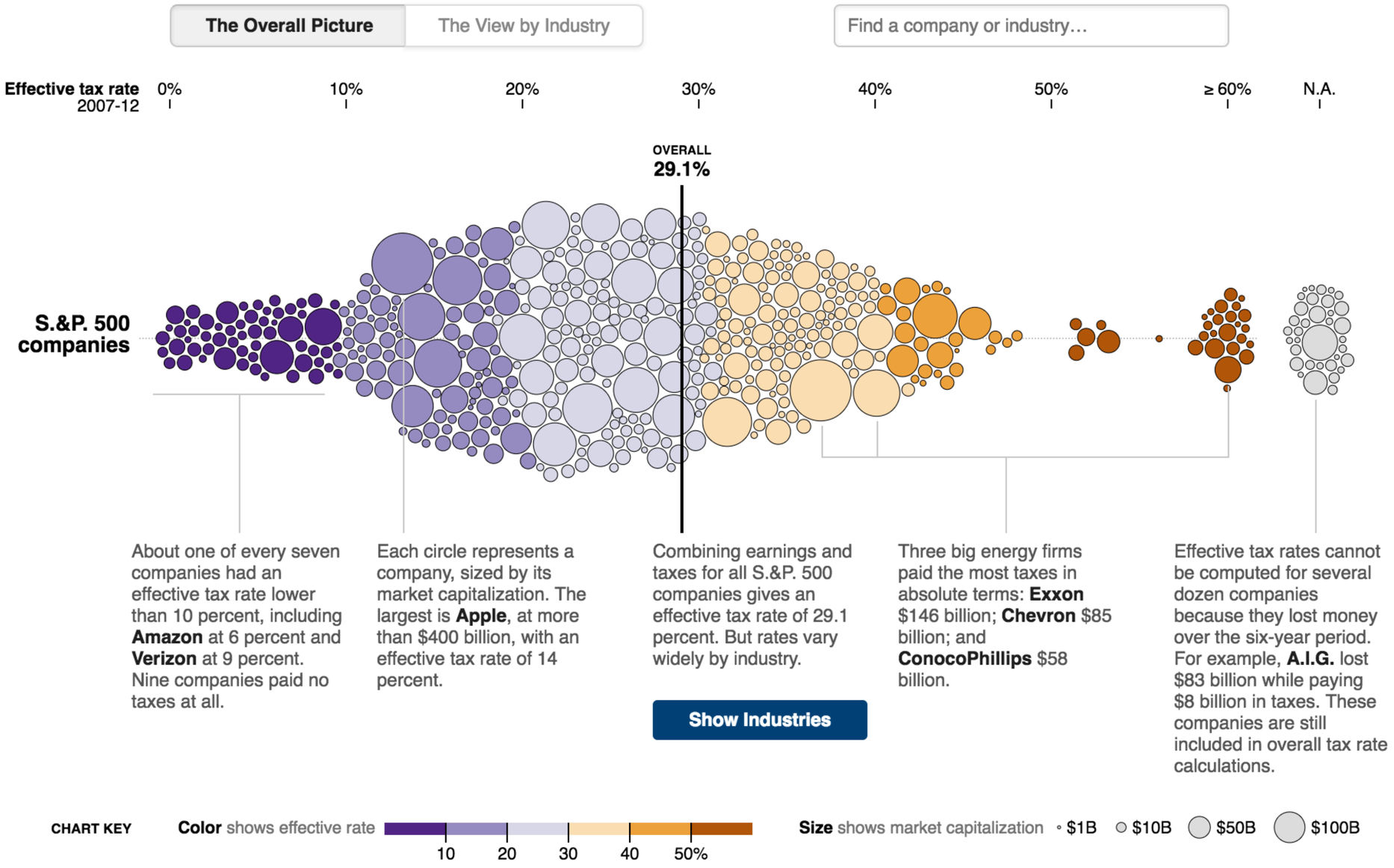
Same

Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

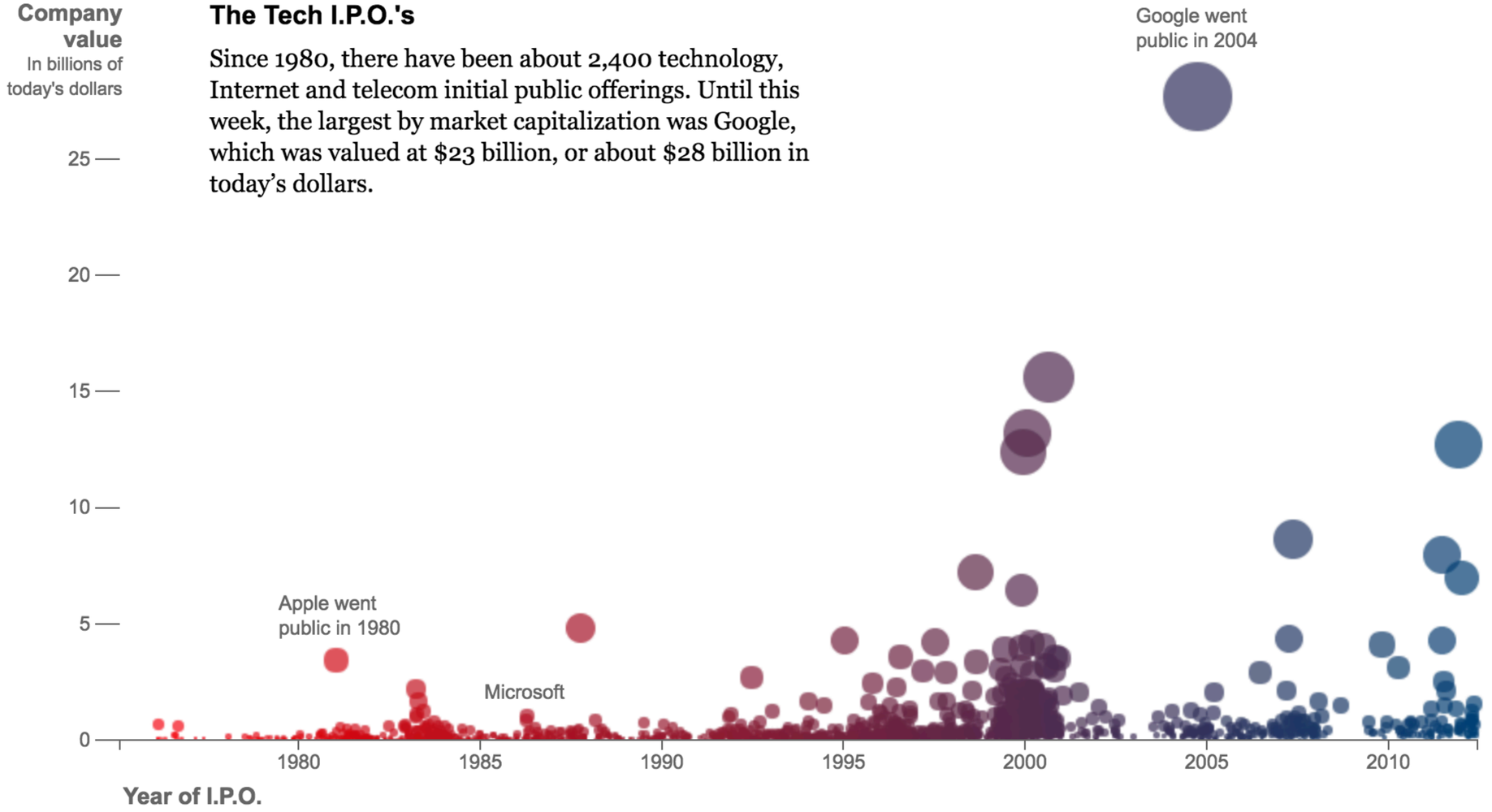
Across U.S. Companies, Tax Rates Vary Greatly

Last week, in a Congressional hearing, Apple got grilled for its low-tax strategy. But not every business can copy that approach. Here is a look at what S.&P. 500 companies paid in corporate income taxes — federal, state, local and foreign — from 2007 to 2012, according to S&P Capital IQ. Related Article »



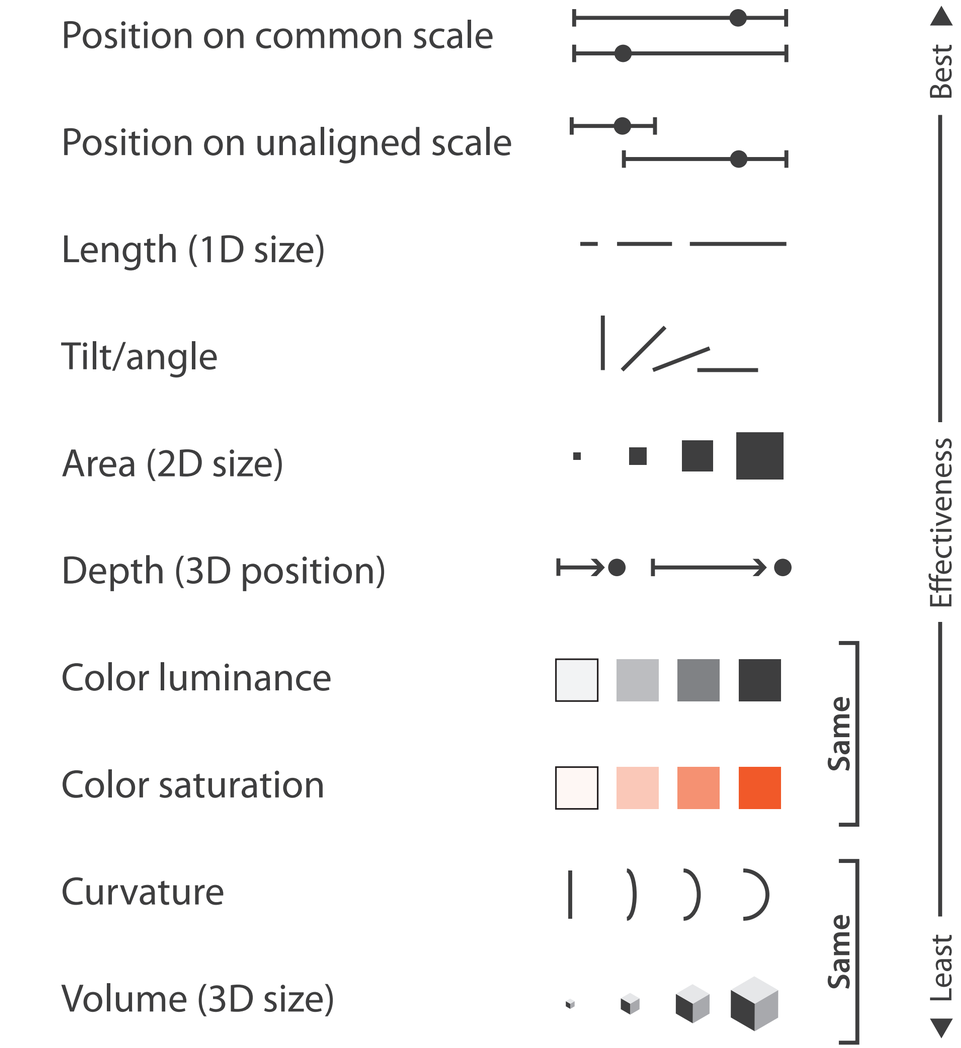
The Facebook Offering: How It Compares

◄ Prev | Next ► 1 2 3 4 5 Find a company

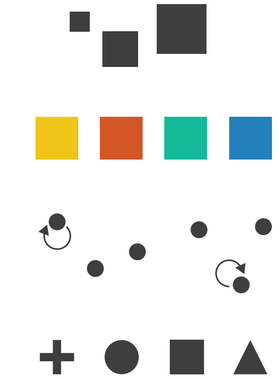


Channels: Rankings

Magnitude Channels: Ordered Attributes



Identity Channels: Categorical Attributes



- **Effectiveness** principle
  - Encode most important attributes with highest ranked channels
- **Expressiveness** principle
  - Match channel and data characteristics

Channels: Rankings

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

Best ▲

Effectiveness

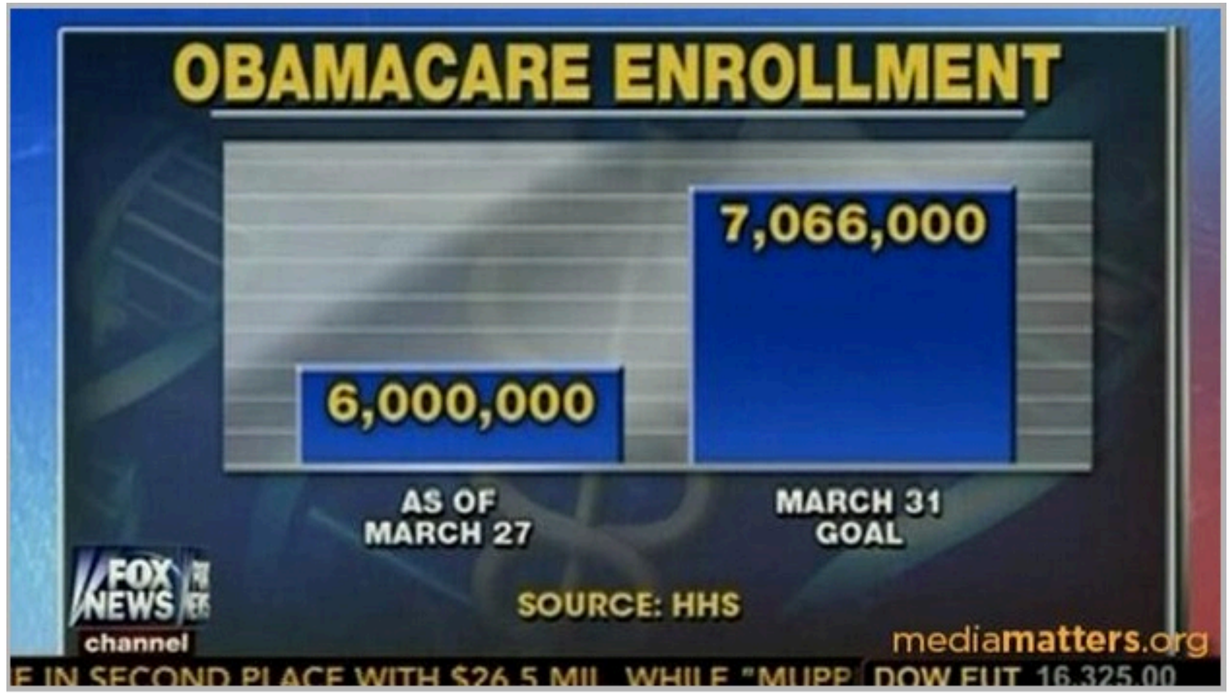
▼ Least

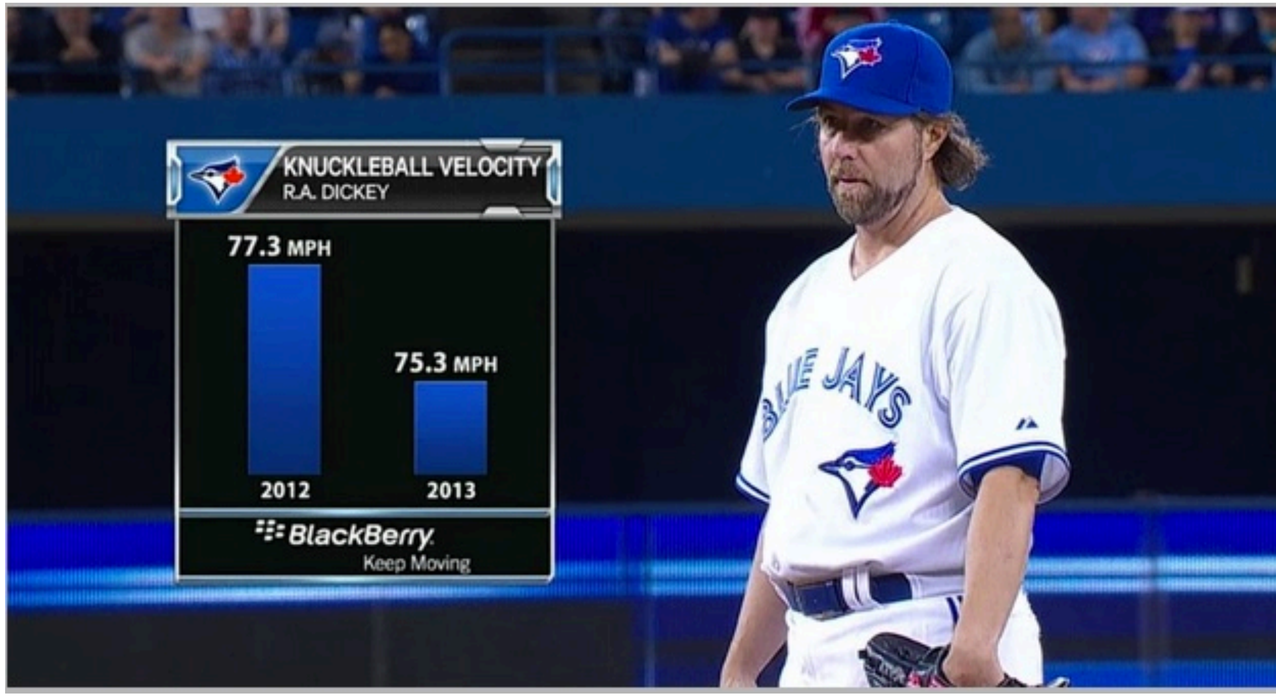
Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

- **Effectiveness** principle
  - Encode most important attributes with highest ranked channels
- **Expressiveness** principle
  - Match channel and data characteristics

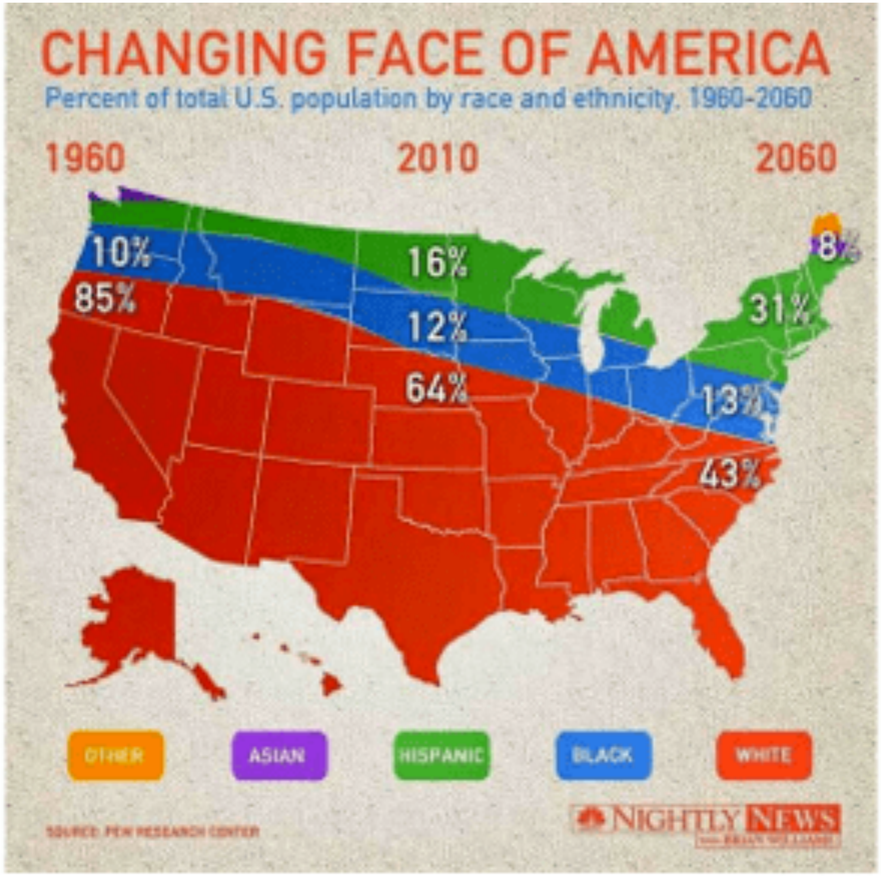
Bad Uses of Size



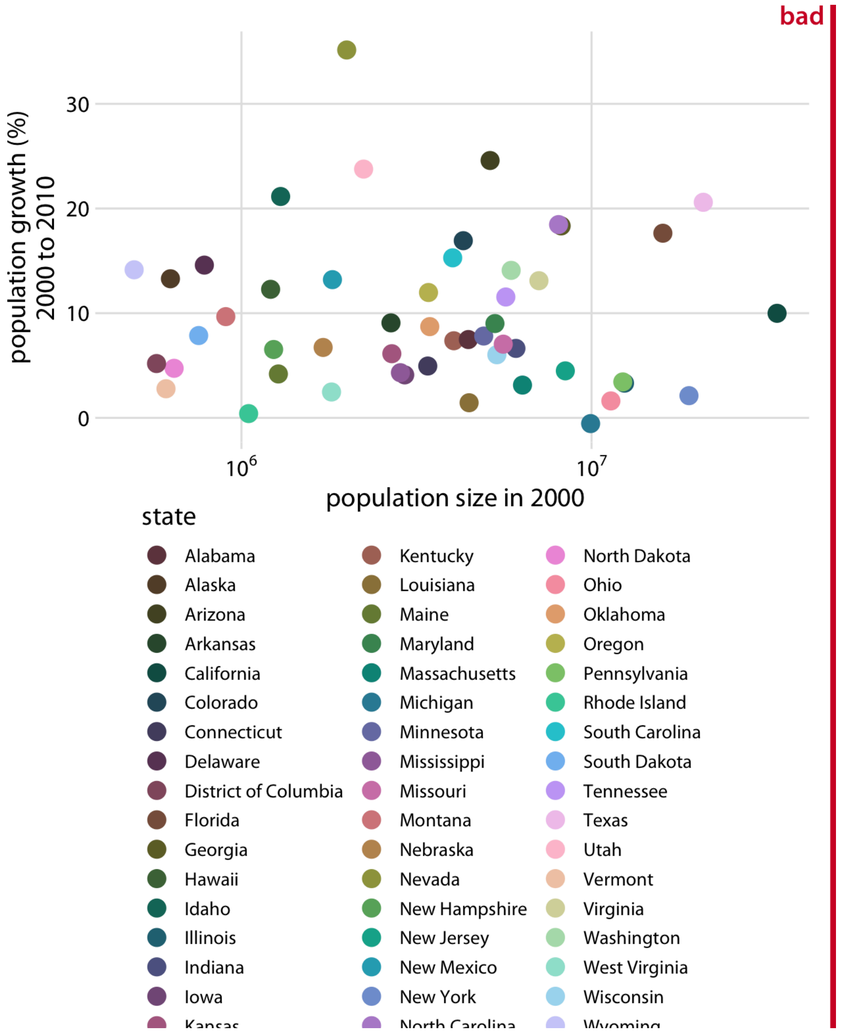


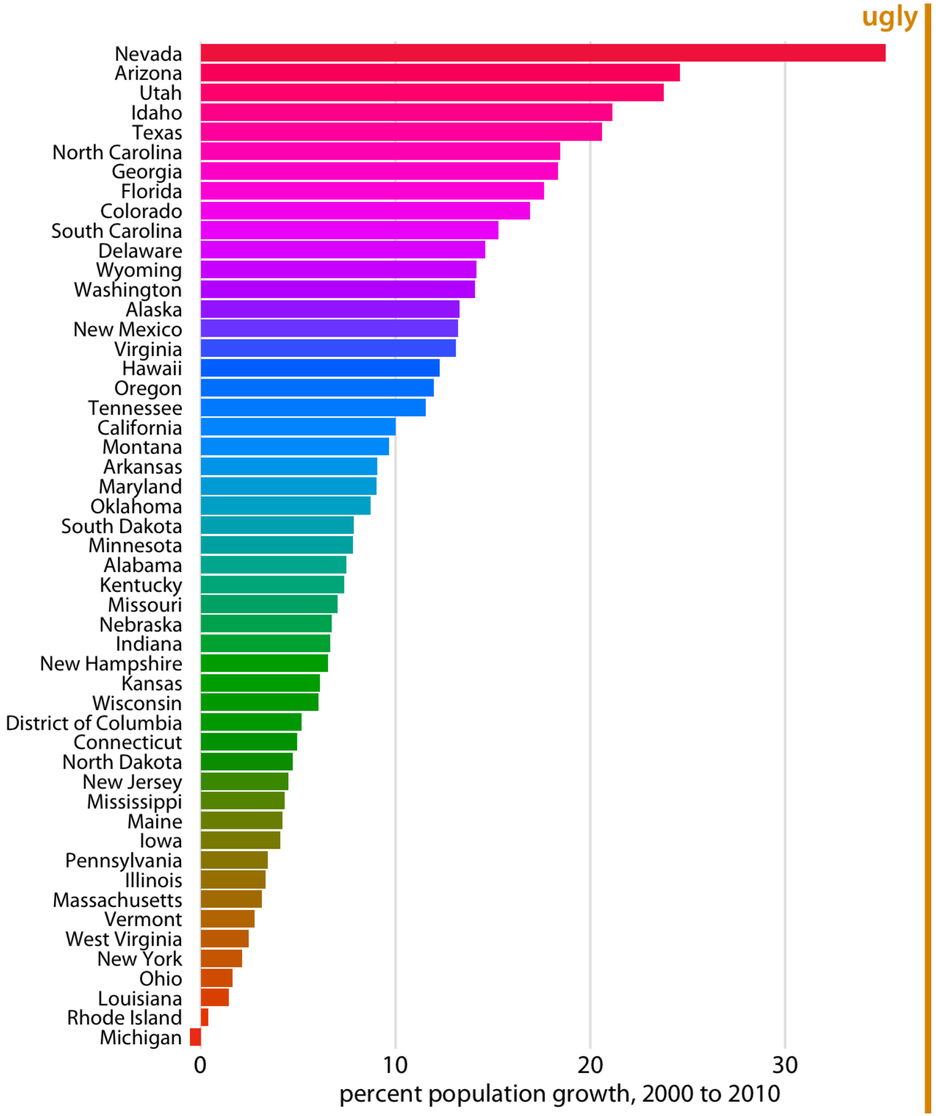
https://serialmentor.com/dataviz/color-pitfalls.html

Bad Use of Position



Bad Uses of Colors

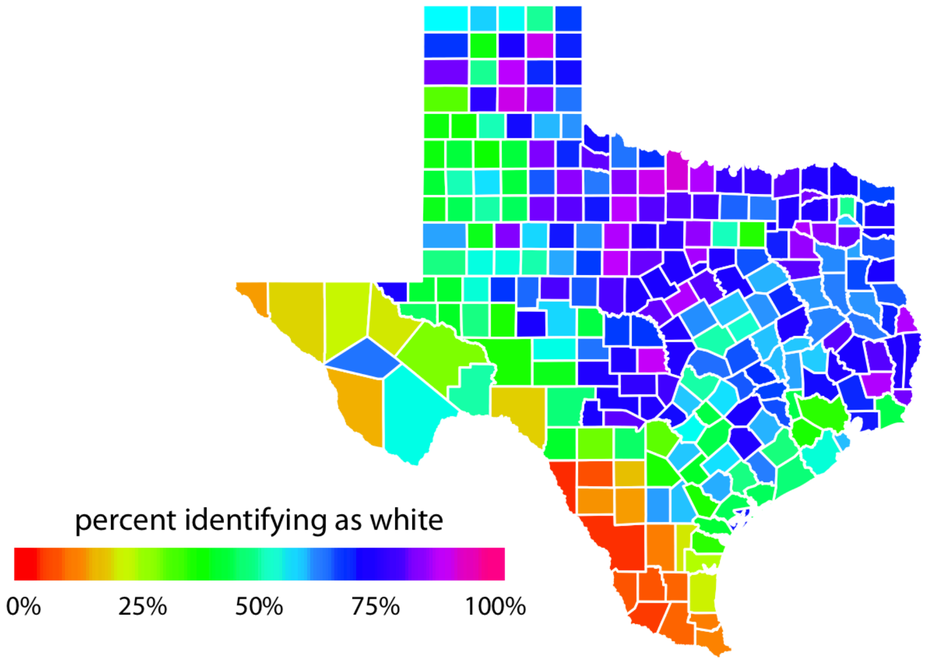




https://serialmentor.com/dataviz/color-pitfalls.html

Bad Use of Colors

bad



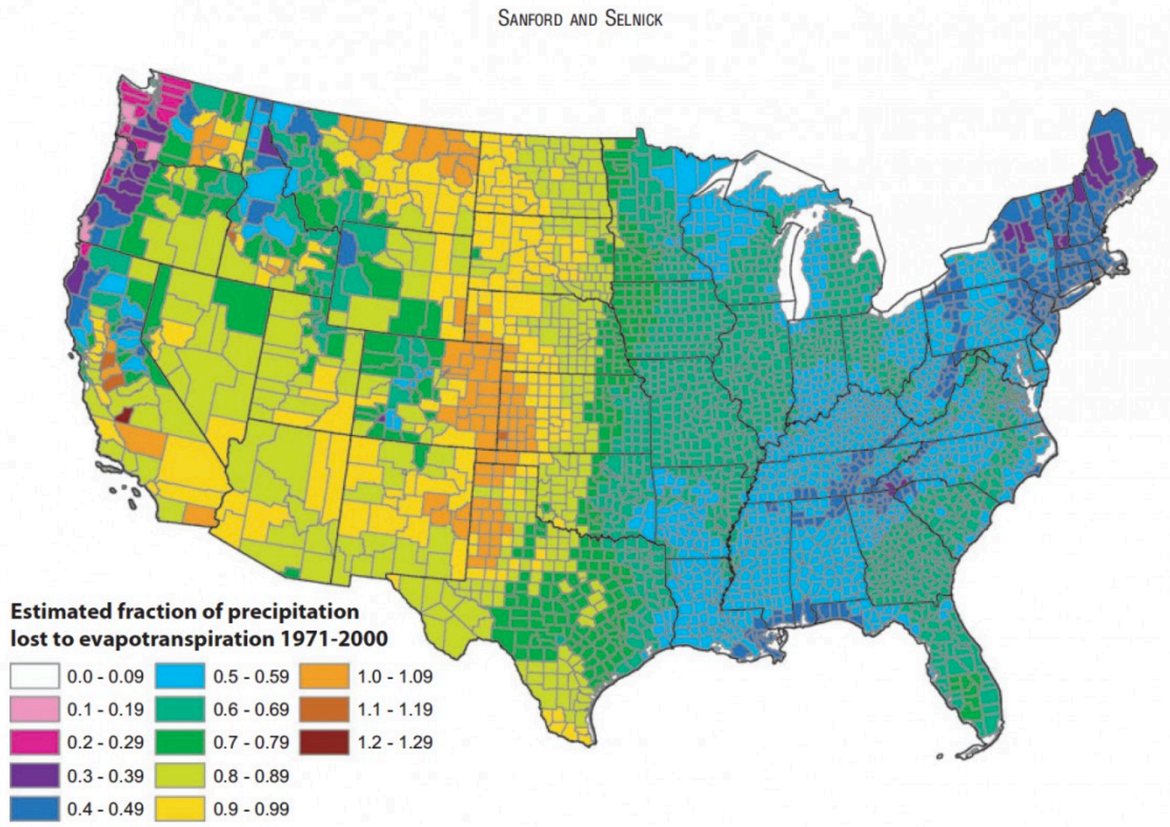
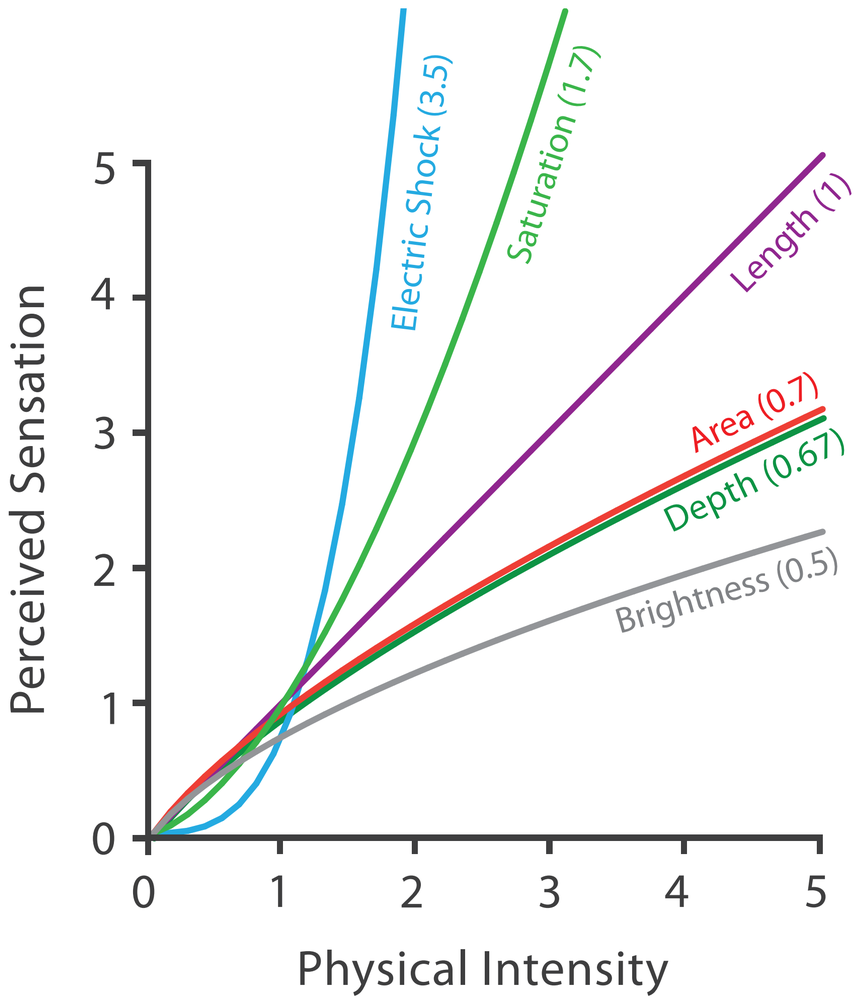


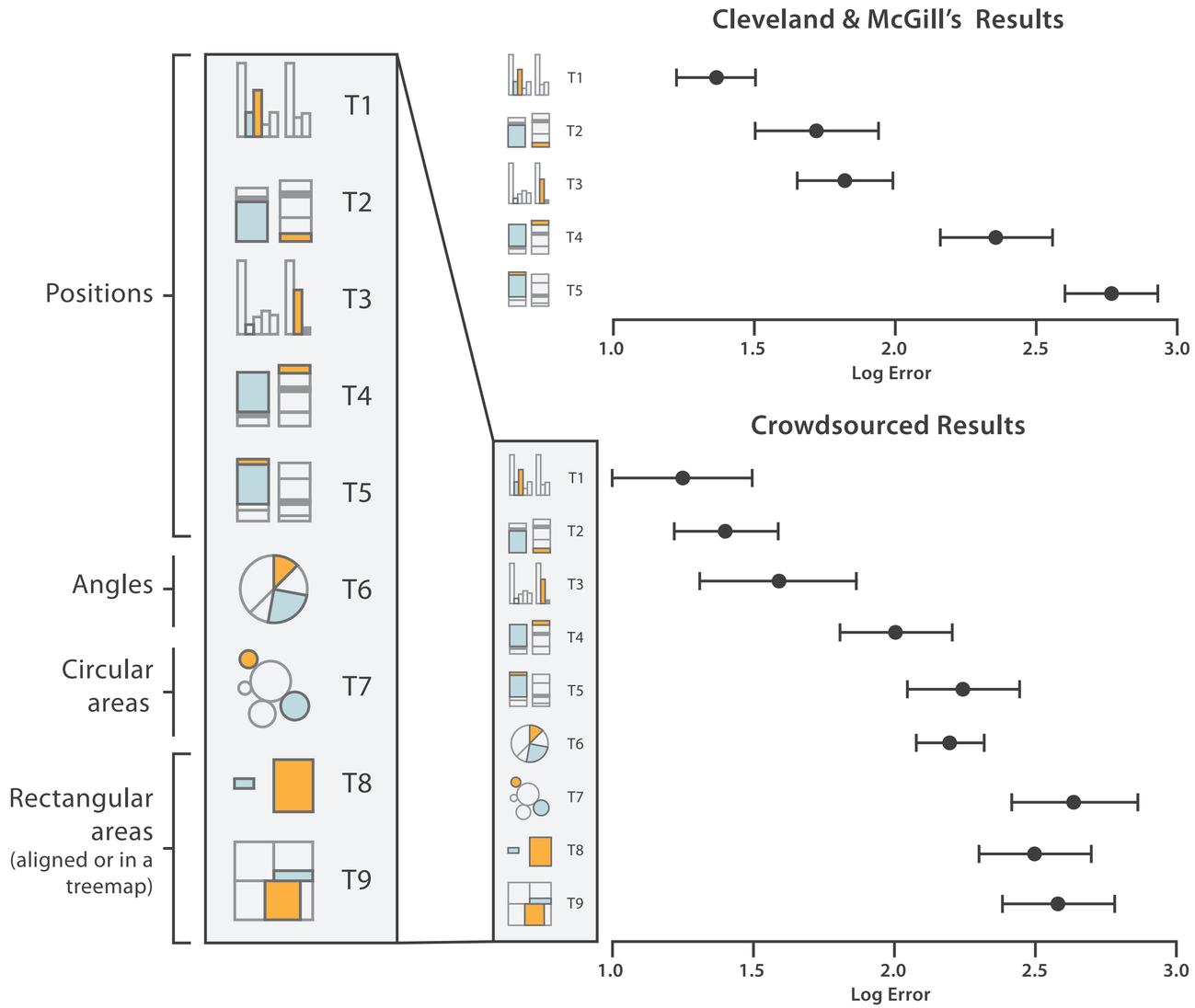
FIGURE 13. Estimated Mean Annual Ratio of Actual Evapotranspiration (ET) to Precipitation (*P*) for the Conterminous U.S. for the Period 1971-2000. Estimates are based on the regression equation in Table 1 that includes land cover. Calculations of ET/*P* were made first at the 800-m resolution of the 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.

Accuracy: Fundamental Theory

Steven's Psychophysical Power Law: $S = I^N$



Accuracy: Vis experiments

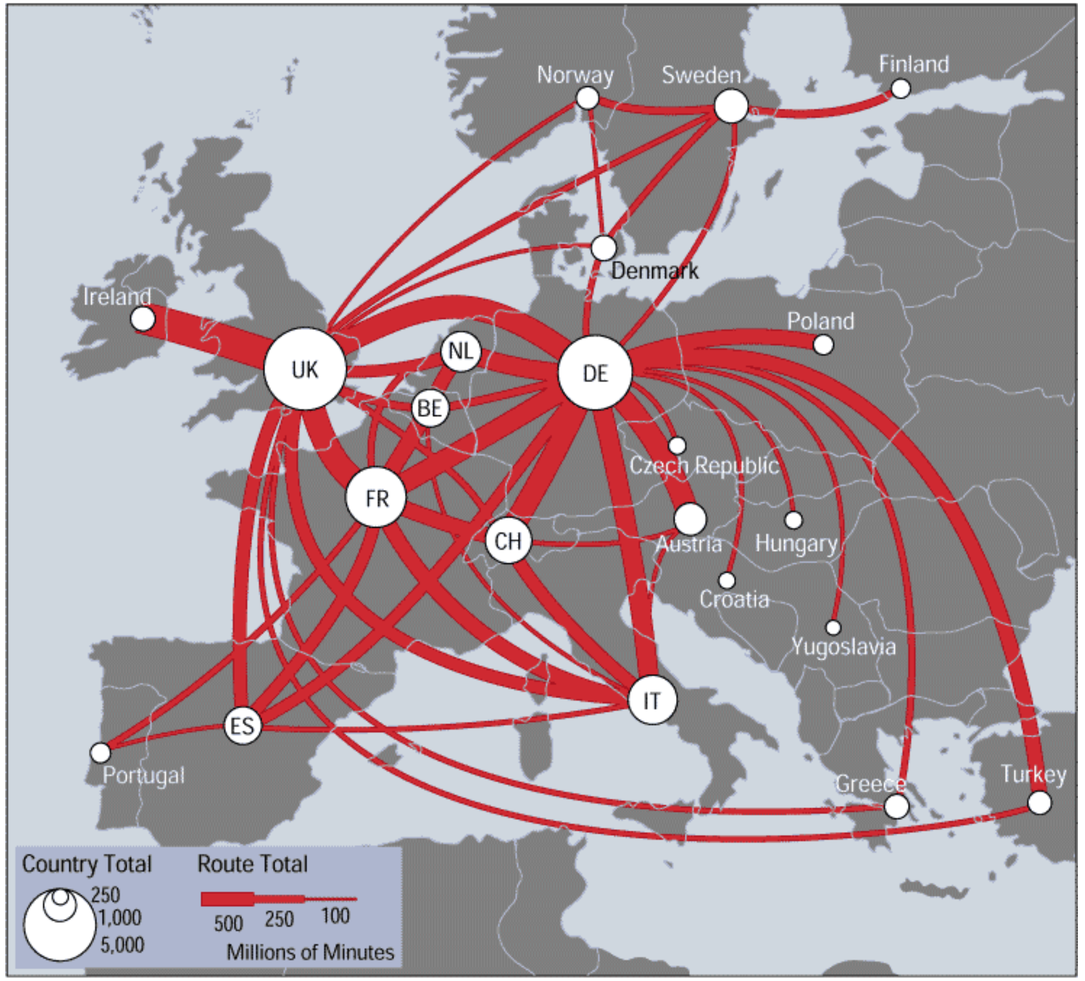


after Michael McGuffin course slides, http://profs.etsmtl.ca/mmcguffin/

[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?

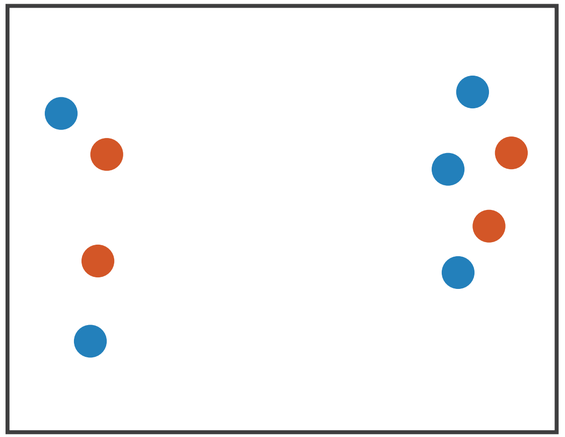
- must be sufficient for number of attribute levels to show
  - line width: few bins



[mappa.mundi.net/maps/maps 014/telegeography.html]

Separability vs. Integrality

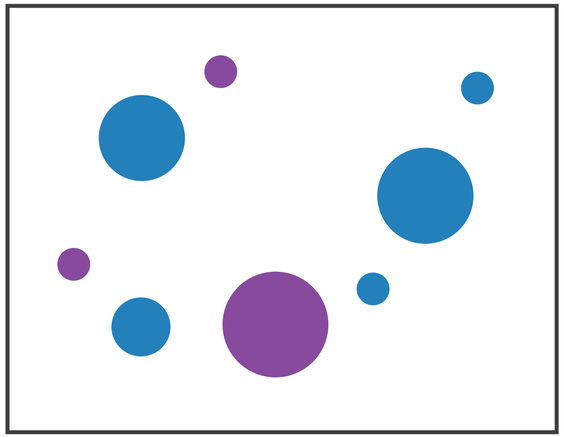
Position
+ Hue (Color)



Fully separable

2 groups each

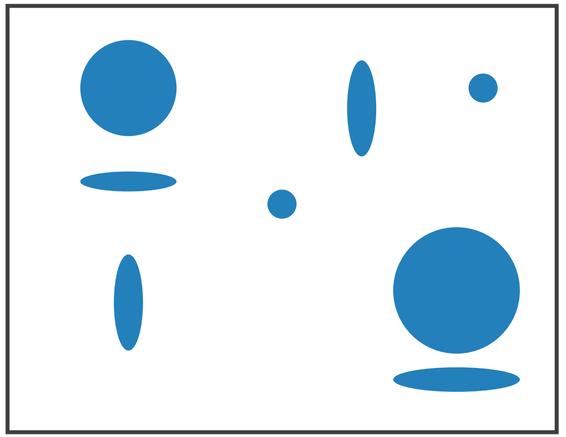
Size
+ Hue (Color)



Some interference

2 groups each

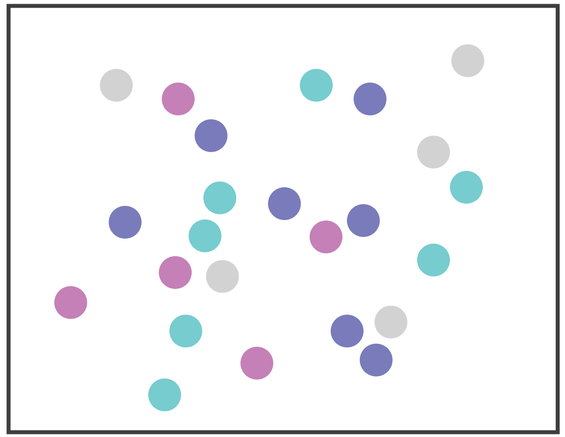
Width
+ Height



Some/significant interference

3 groups total: integral area

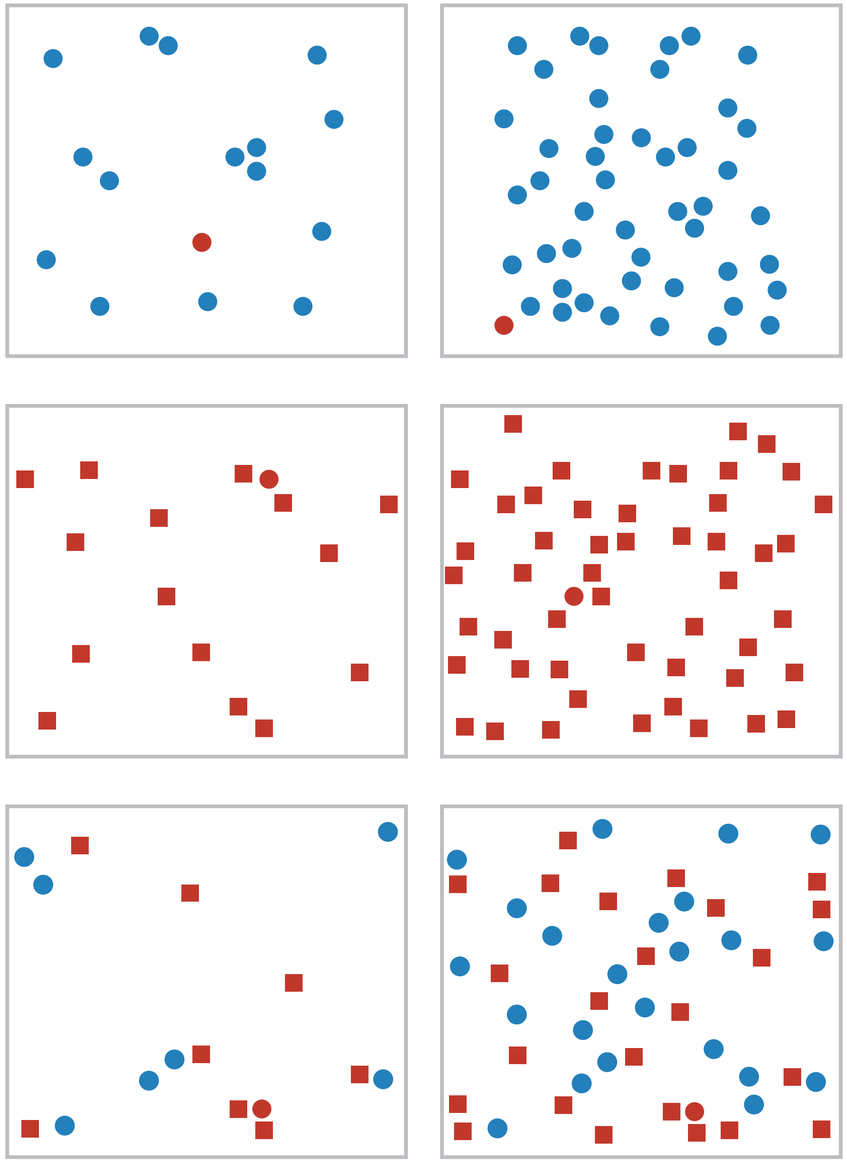
Red
+ Green



Major interference

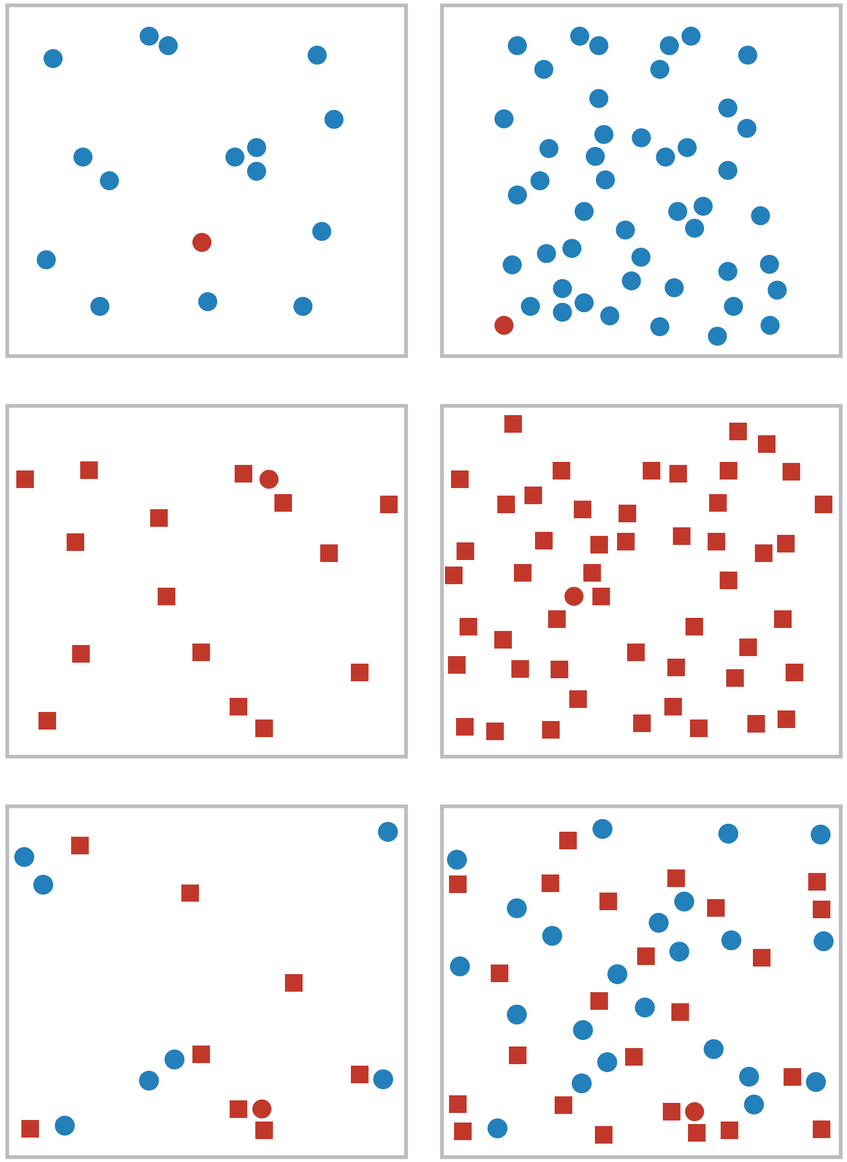
4 groups total: integral hue

Popout



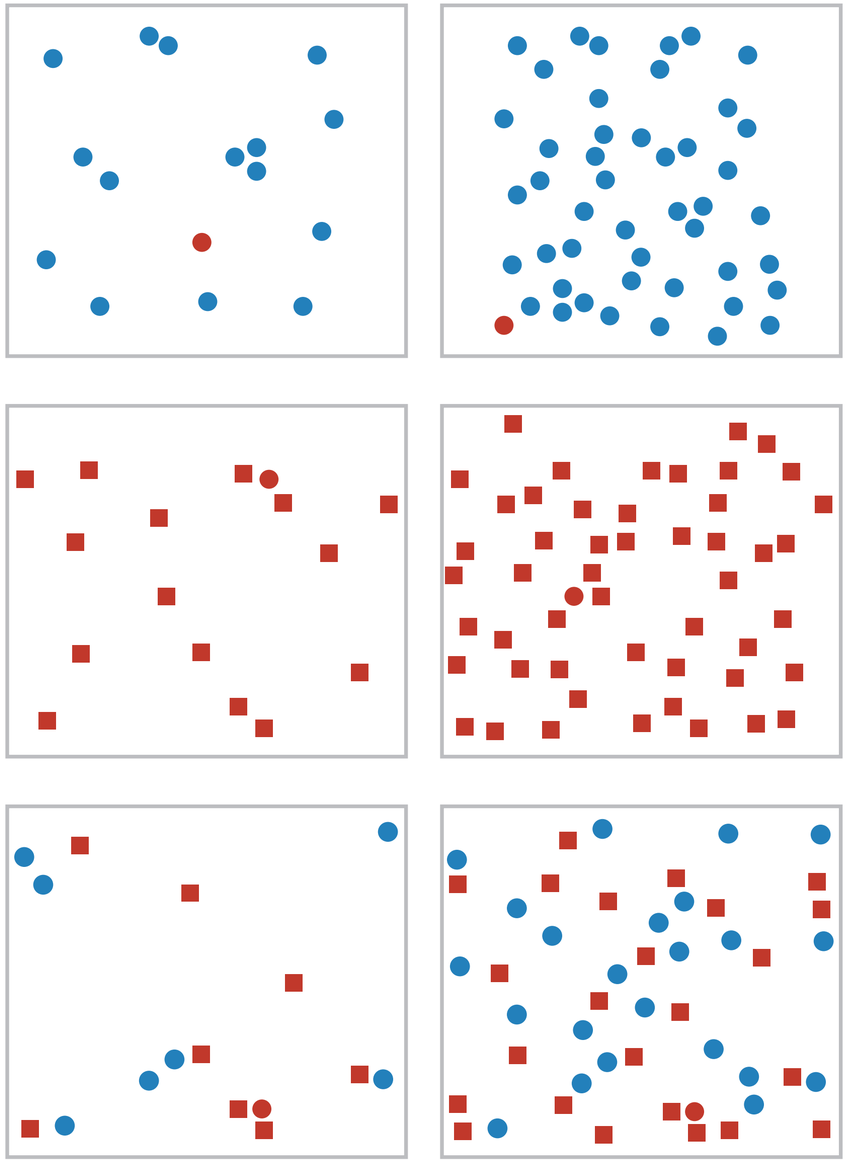
Popout

- find the red dot
  - –how long does it take?

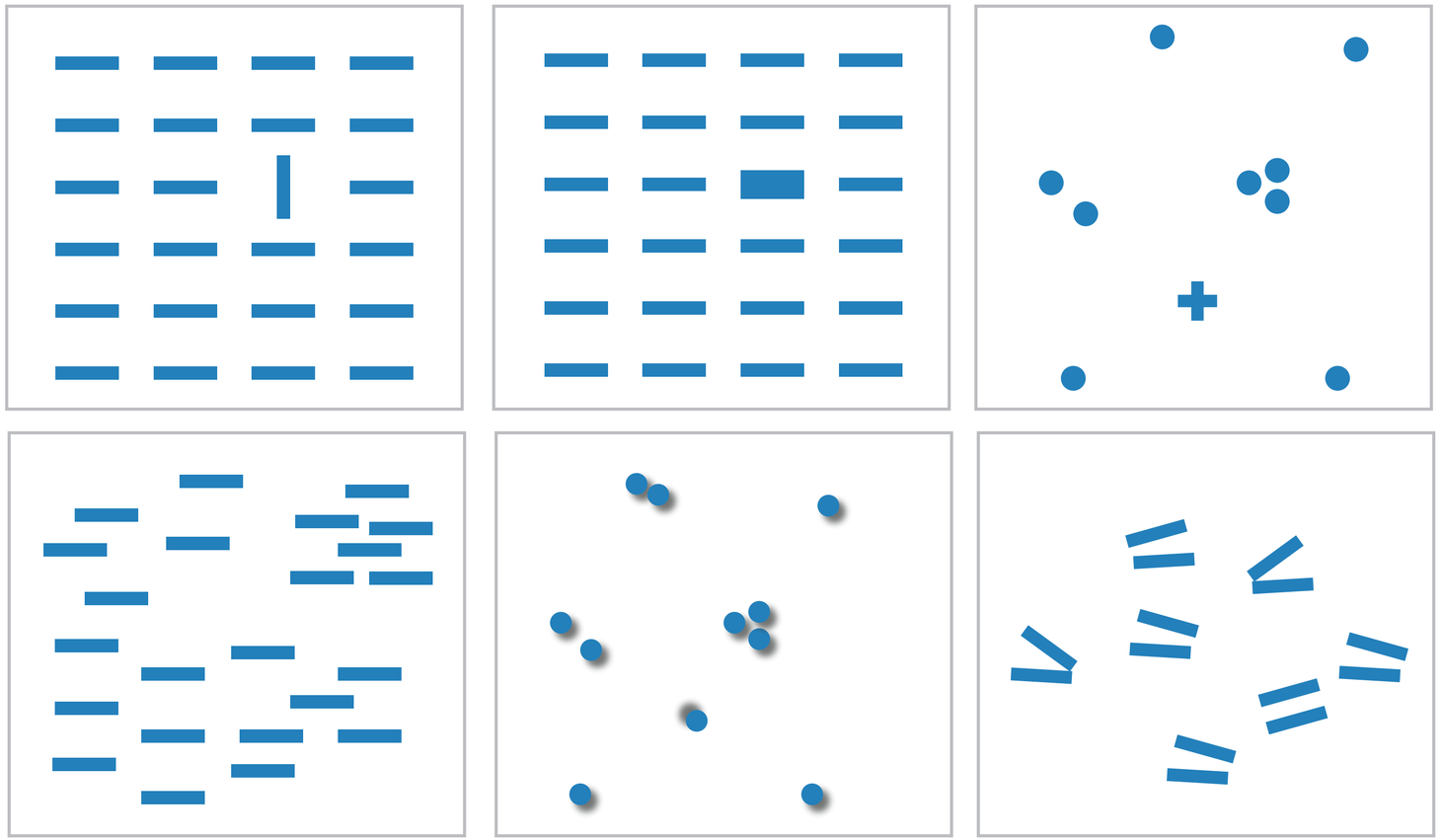


Popout

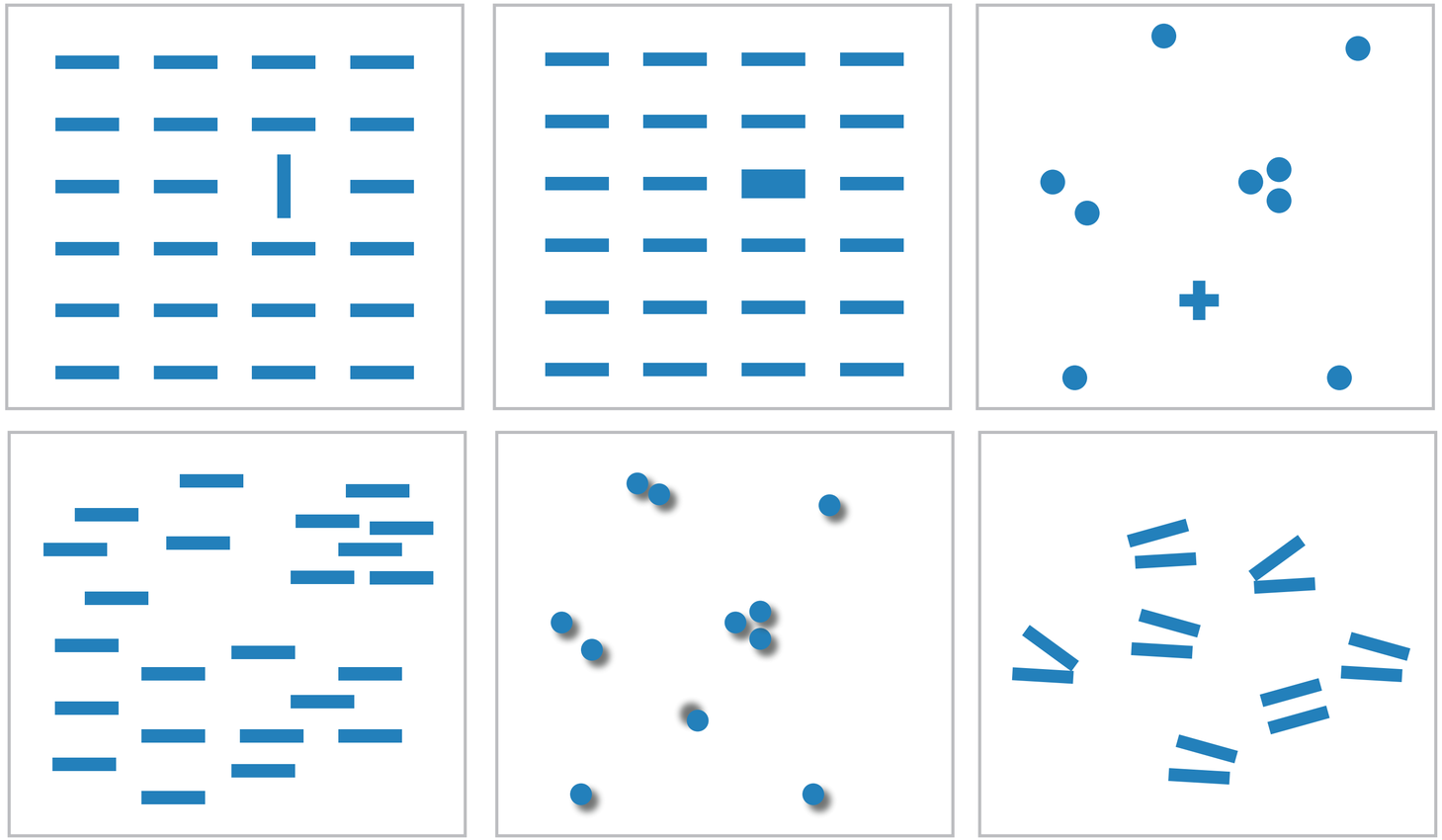
- find the red dot
  - –how long does it take?
- parallel processing on many individual channels
  - –speed independent of distractor count
  - –speed depends on channel and amount of difference from distractors
- serial search for (almost all) combinations
  - –speed depends on number of distractors



Popout

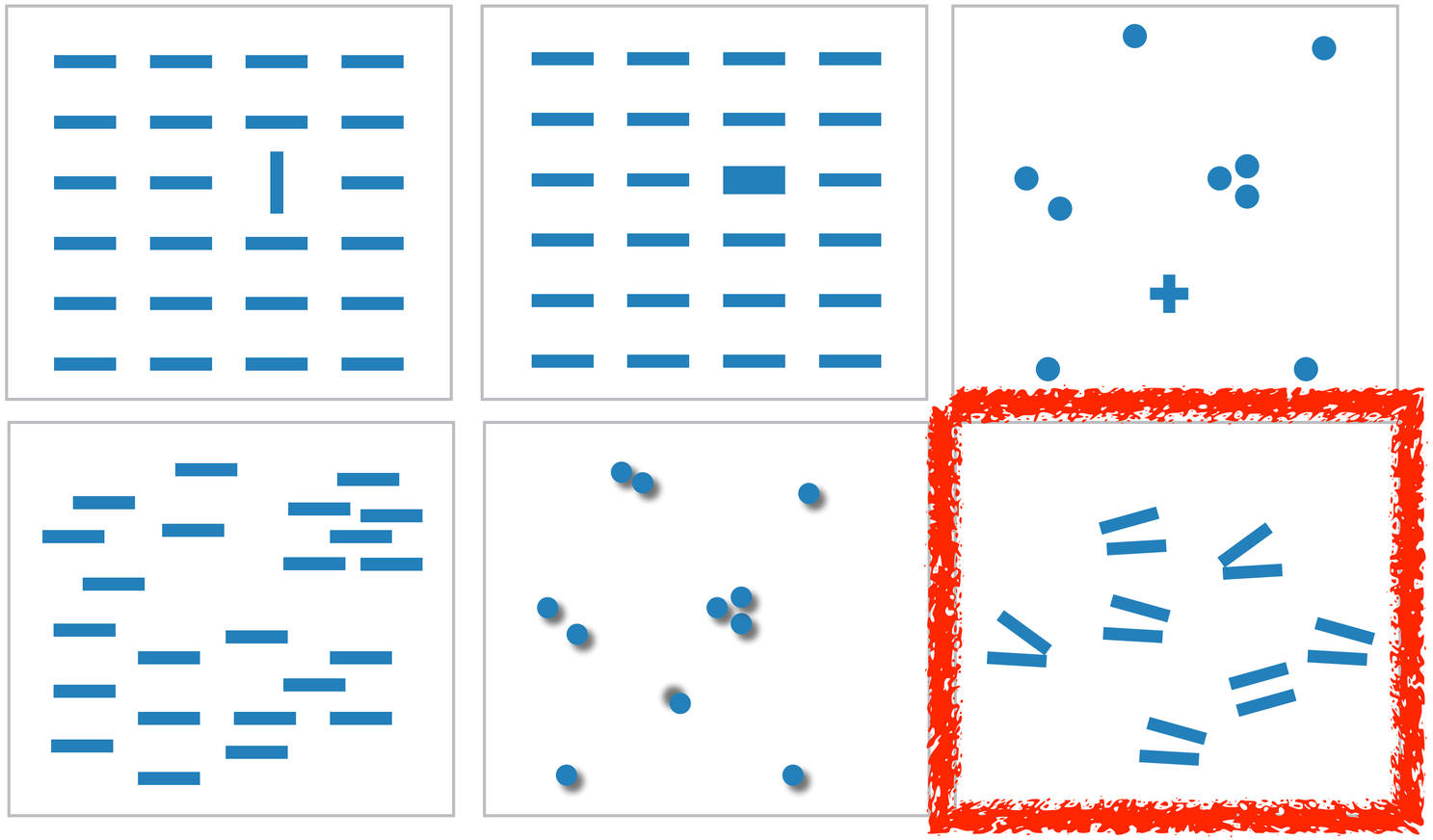


Popout



- many channels: tilt, size, shape, proximity, shadow direction, ...

Popout



- many channels: tilt, size, shape, proximity, shadow direction, ...
- but not all! parallel line pairs don’t pop out from tilted pairs

Grouping

- containment
- connection

Marks as Links

Containment

Connection

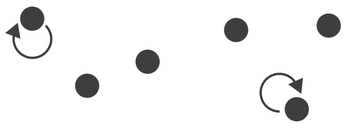
- proximity
  - same spatial region
- similarity
  - same values as other categorical channels

Identity Channels: Categorical Attributes

Spatial region

Color hue

Motion



Shape

Relative vs. absolute judgements

after [Graphical Perception:Theory, Experimentation, and Application to the Development of Graphical Methods. Cleveland and McGill. Journ. American Statistical Association 79:387 (1984), 531–554.]

Relative vs. absolute judgements

- perceptual system mostly operates with relative judgements, not absolute

after [Graphical Perception:Theory, Experimentation, and Application to the Development of Graphical Methods. Cleveland and McGill. Journ. American Statistical Association 79:387 (1984), 531–554.]

Relative vs. absolute judgements

- perceptual system mostly operates with relative judgements, not absolute
  - that's why accuracy increases with common frame/scale and alignment

after [Graphical Perception:Theory, Experimentation, and Application to the Development of Graphical Methods. Cleveland and McGill. Journ. American Statistical Association 79:387 (1984), 531–554.]

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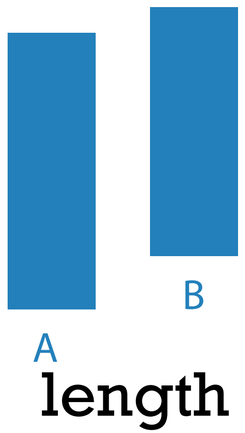

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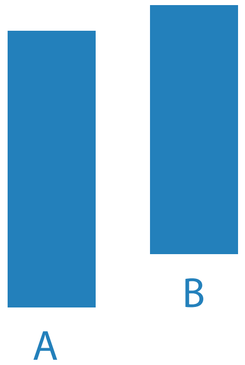

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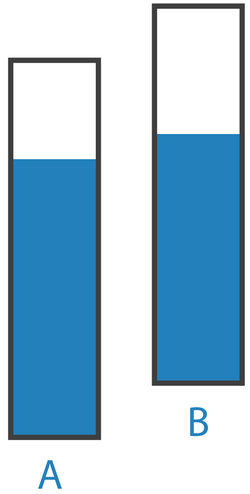

position along unaligned common scale

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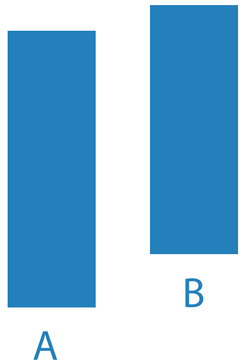

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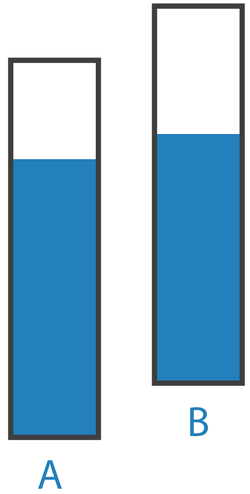

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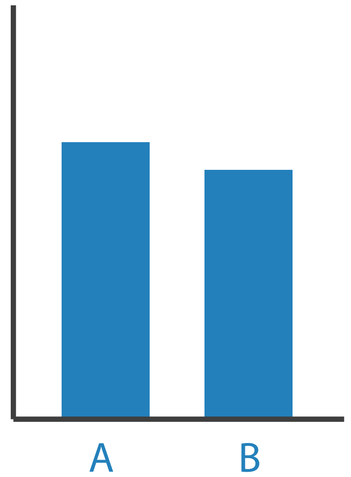

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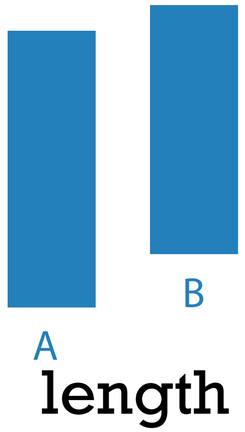

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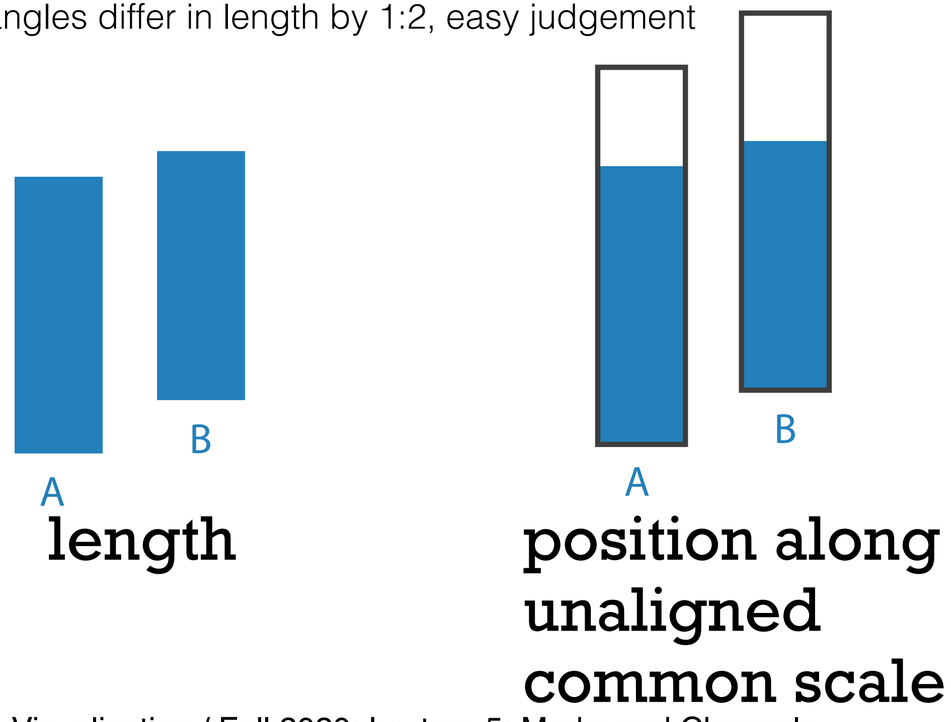

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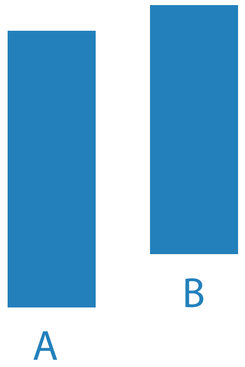

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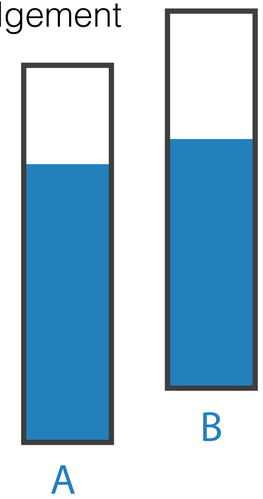

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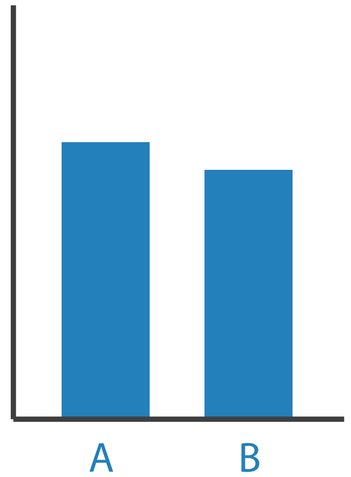

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