Ch 5: Marks and Channels

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http://www.cs.ubc.ca/~tmm/courses/547-17

News

- comments marks out for 3/Tasks and 4/Validation,
  - lect 2 avg 86, min 73, max 94
  - lect 3 avg 85, min 78, max 98
  - lect 4 avg 88, min 84, max 100

Now

- first, work in small groups
  - exercise: decoding marks and channels
  - 45 min, +/- 15 min
    - status checkins at 30 min, 45 min, (60 min)

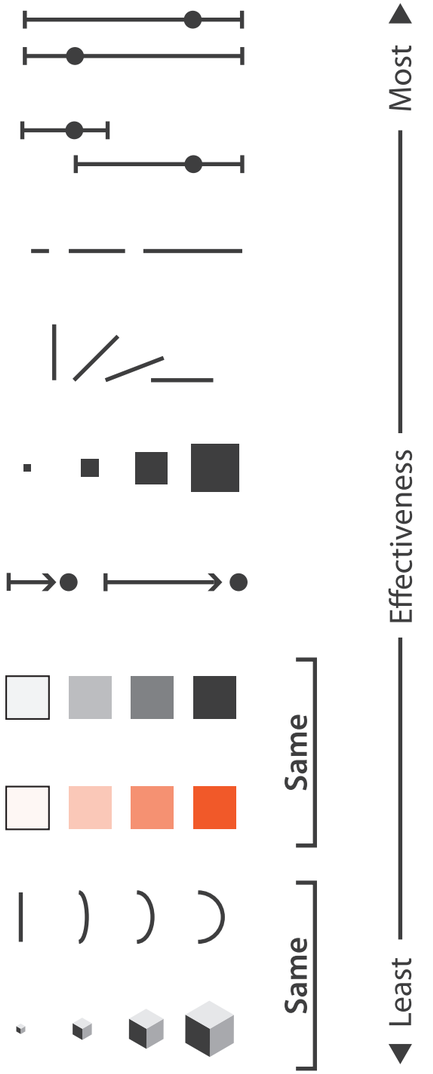
- then readings discussion

VAD Ch 5: Marks and Channels

Channels: Expressiveness Types and Effectiveness Ranks

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)



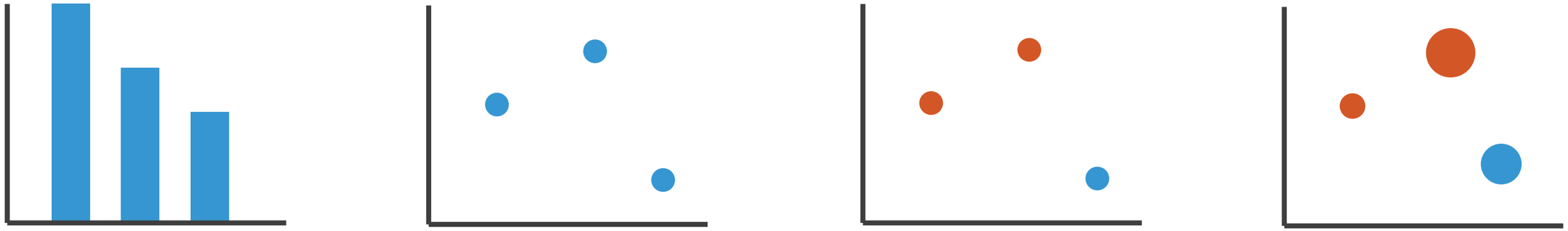
Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

[VAD Fig 5.1]

Encoding visually

- analyze idiom structure



Definitions: Marks and channels

- marks
  - geometric primitives

Points Lines Areas

- channels
  - control appearance of marks

Position

→ Horizontal → Vertical → Both

Color

Shape

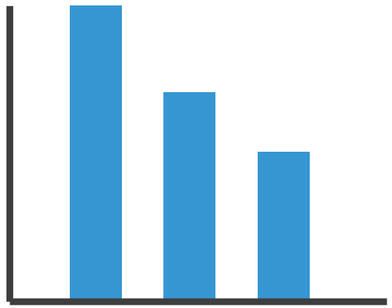
Tilt

Size

→ Length → Area → Volume

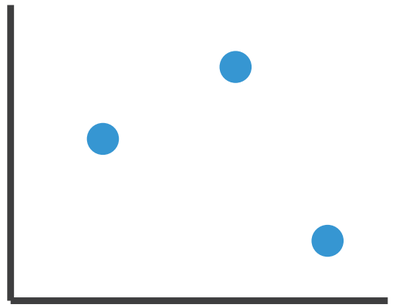
Encoding visually with marks and channels

- analyze idiom structure
  - as combination of marks and channels



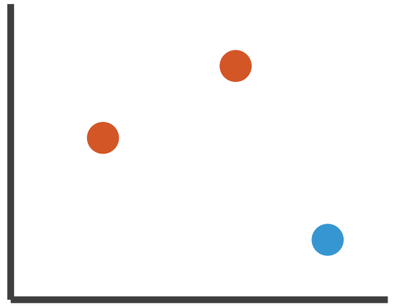
1:
vertical position

mark: line



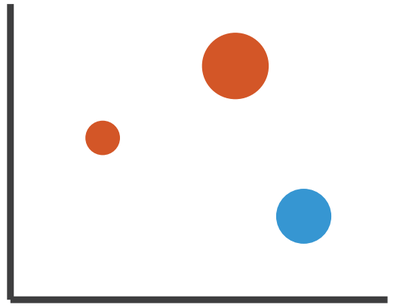
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

mark: point



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

mark: point

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: 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

Grouping

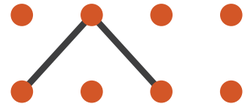
- containment
- connection

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

Marks as Links

Containment

Connection

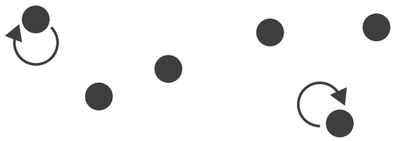


Identity Channels: Categorical Attributes

Spatial region

Color hue

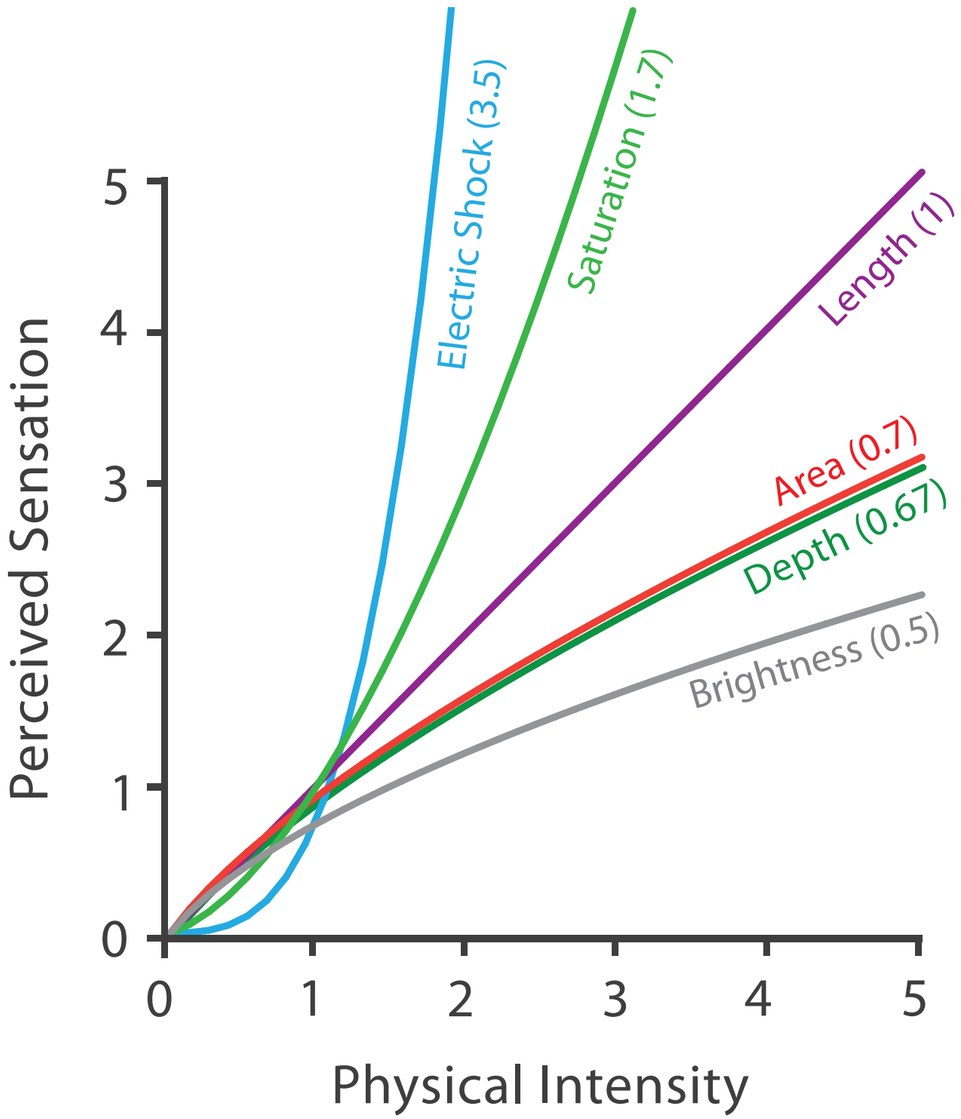
Motion



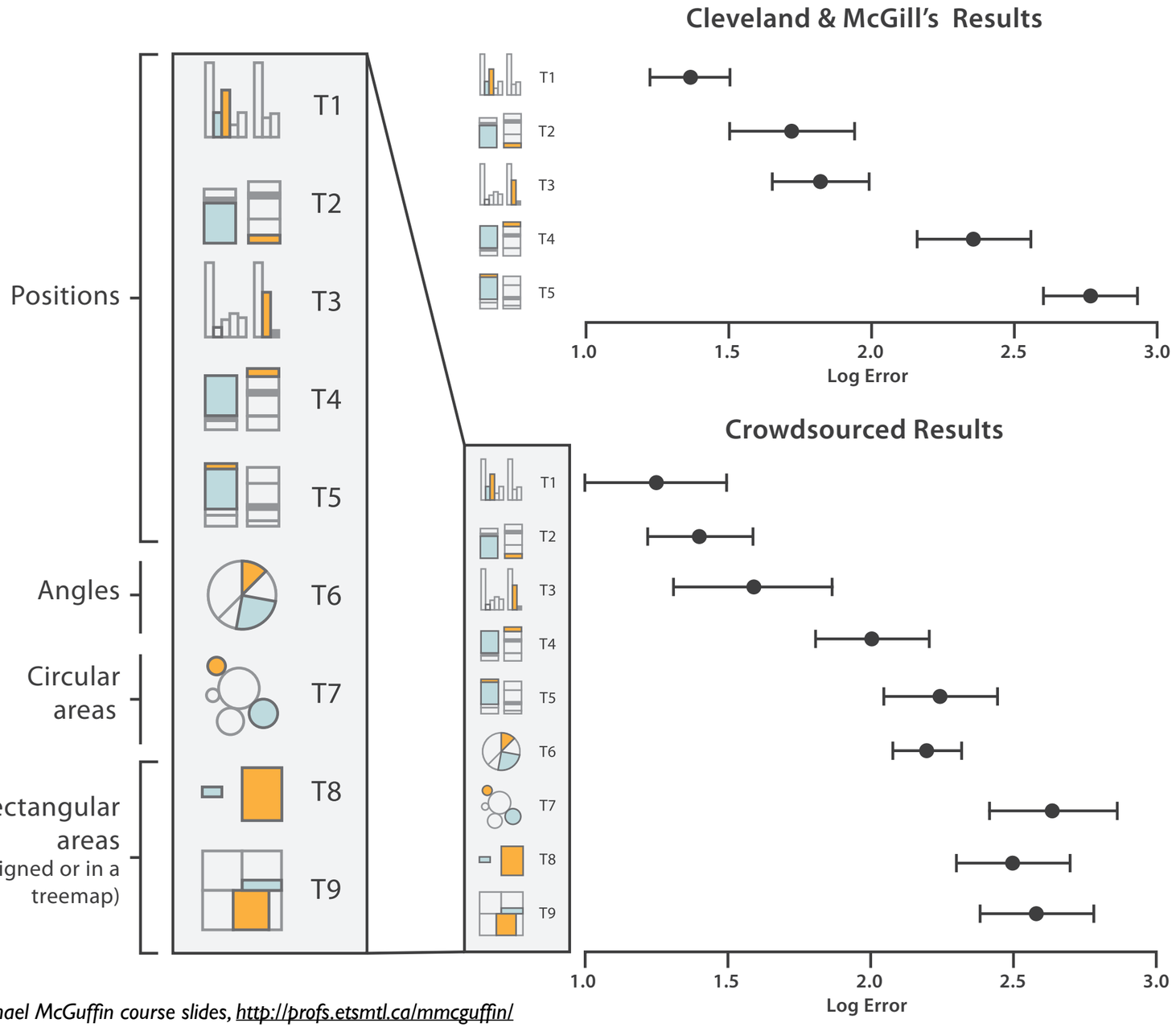
Shape

Accuracy: Fundamental Theory

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



Accuracy: Vis experiments

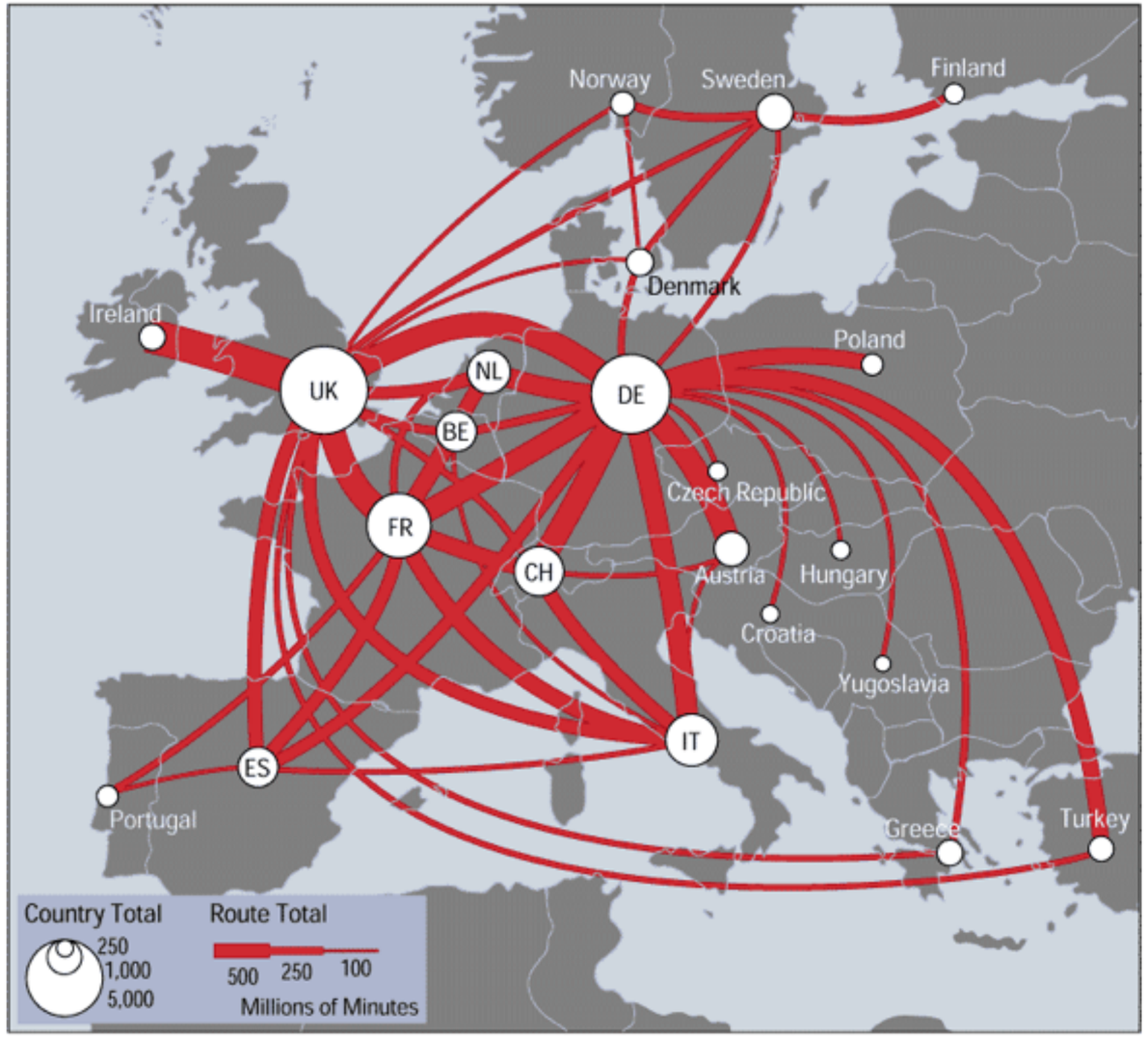


after Michael McGuffin course slides, http://profs.etsmtl.ca/mmcguffin/

[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?

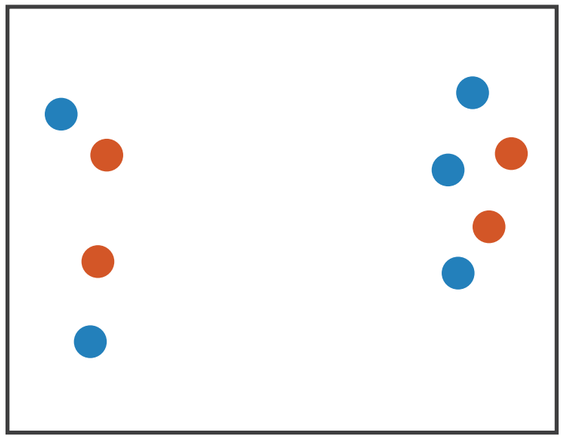
- must be sufficient for number of attribute levels to show
  - linewidth: few bins



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

Separability vs. Integrality

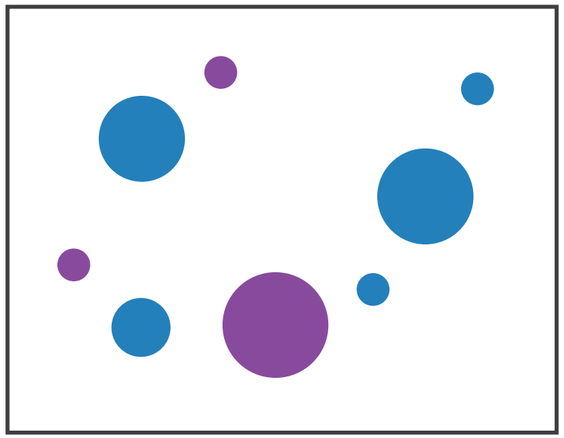
Position
+ Hue (Color)



Fully separable

2 groups each

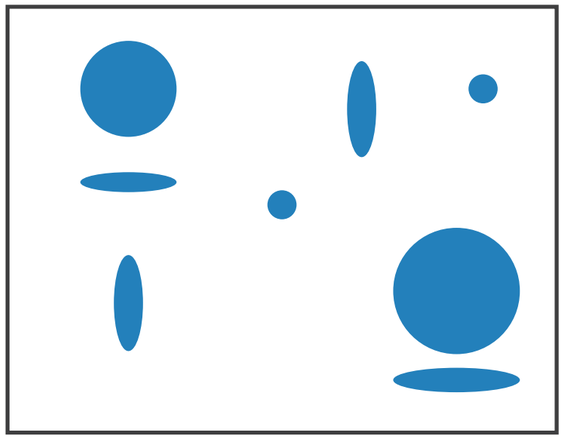
Size
+ Hue (Color)



Some interference

2 groups each

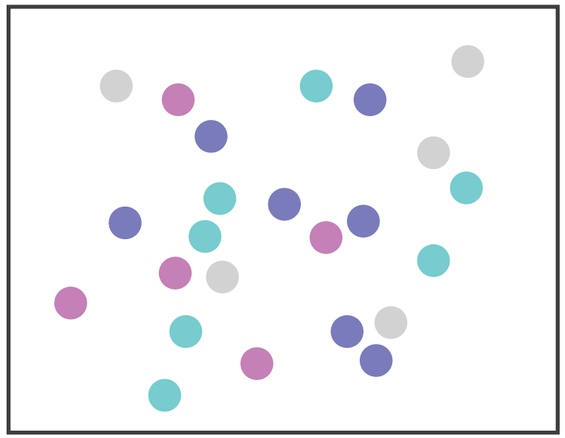
Width
+ Height



Some/significant interference

3 groups total: integral area

Red
+ Green



Major interference

4 groups total: integral hue

Further reading: Articles

- **Perception in Vision web page with demos, Christopher Healey.** (see also Attention and Visual Memory in Visualization and Computer Graphics, Christopher G. Healey and James T. Enns, IEEE TVCG 18(7):1170-1188 2012.)
- Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design. Jeffrey Heer and Michael Bostock. Proc. CHI 2010
- Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.
- A Model for Studying Display Methods of Statistical Graphics (with Discussion). William S. Cleveland. Journal of Computational and Statistical Graphics 2(4):323-364 1993.
- Automating the Design of Graphical Presentations of Relational Information. Jock Mackinlay, ACM Transaction on Graphics, vol. 5, no. 2, April 1986, pp. 110-141.
- Taxonomy-Based Glyph Design---With a Case Study on Visualizing Workflows of Biological Experiments. Eamonn Maguire, Philippe Rocca-Serra, Susanna-Assunta Sansone, Jim Davies, and Min Chen. IEEE TVCG (Proc. InfoVis 12) 18(12):2603-2612 2012.
- Glyph-Based Visualization: Foundations, Design Guidelines, Techniques and Applications. Rita Borgo, Johannes Kehrer, David H.S. Chung, Eamonn Maguire, Robert S. Laramee, Helwig Hauser, Matthew Ward, and Min Chen. Eurographics State of the Art Reports (STAR):39-63 2013.
- On the Theory of Scales of Measurement. S. S. Stevens. Science 103(2684):677-680, 1946.
- Feature Analysis in Early Vision: Evidence from Search Asymmetries. Treisman and Gormican. Psychological Review 95(1): 15-48, 1988.

Further reading: Books

- Visualization Analysis and Design. Munzner. CRC Press, 2014.
  - *Chap 5: Marks and Channels*
- **Visual Thinking for Design. Ware. Morgan Kaufmann, 2008.**
- **Information Visualization: Perception for Design, 3rd edition. Ware.** Morgan Kaufmann /Academic Press, 2013.
- How Maps Work: Representation, Visualization, and Design. Alan M. MacEachren. Guilford Press, 1995.
- The Grammar of Graphics, Leland Wilkinson, Springer-Verlag 1999.
- Semiology of Graphics, Jacques Bertin, Gauthier-Villars 1967, EHESS 1998.
- Psychophysics: Introduction to its Perceptual, Neural, and Social Prospects. Stevens. Wiley, 1975.

Next Time

- to read
  - VAD Ch. 6: Rules of Thumb
  - paper: Artery Viz (type: design study / evaluation)

- reminder: office hrs after class today