PERCEPTION

CS 448B | Fall 2023

MANEESH AGRAWALA

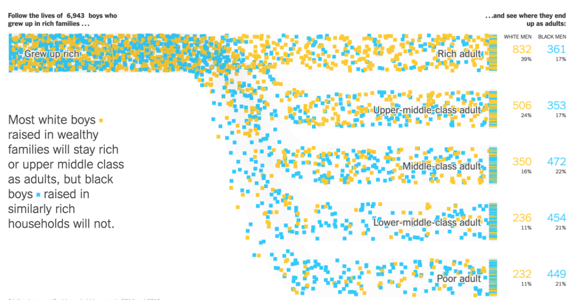
1

Extensive Data Shows Punishing Reach of Racism for Black Boys

By EMILY BADGER, CLAIRE CAIN MILLER, ADAM PEARCE and KEVIN QUEALY MARCH 19, 2018

Black boys raised in America, even in the wealthiest families and living in some of the most well-to-do neighborhoods, still earn less in adulthood than white boys with similar backgrounds, according to a sweeping new study that traced the lives of millions of children.

White boys who grow up rich are likely to remain that way. Black boys raised at the top, however, are more likely to become poor than to stay wealthy in their own adult households.



https://www.nytimes.com/interactive/2018/03/19/upshot/race-class-white-and-black-men.html

2

READING RESPONSE: QUESTIONS/THOUGHTS

When discussing **alternatives to d3**, it seems to be other HTML and javascript type software. However, I am curious if anyone considered using a c# type software. … T**he assignment could be easily done in a day in unity**, as many of the components are built into unity for that kind of interaction.

"How can we find the balance between simplicity and flexibility in making interactive data visualizations?" My guess is that **the most elegant solution for interactive visualizations varies from case to case and relies on a variety of factors** such as how the data is organized.

The **"Overview + Detail", "Details on Demand", and "Cross-Filtering" sections were very novel** to me in terms of the actions required for users to interact with the data. **I don't know if the average person would be able to guess how they should click** in order to see the information they are interested in, or even more important, the information that the source hopes to emphasize to the reader.

The piece on "**The death of interactive infographics?"** … begins to veer towards generally recommending **against data visualization unless 3 specific requirements can be met** regarding the audience: **Time, Goals, and Care.** … An interesting counterpoint that I considered is, **what if you have a visualization where interactivity is essential to explain the data**, regardless of the audience's time or care.

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GRAPHICAL PERCEPTION

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DESIGN PRINCIPLES [Mackinlay 1986]

Expressiveness

A set of facts is *expressible* in a visual language if the sentences (i.e., the visualizations) in the language express ***all*** the facts in the set of data, and ***only*** the facts in the data.

Effectiveness

A visualization is more *effective* than another visualization if the information conveyed by one visualization is more readily ***perceived*** than the information in the other visualization.

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DESIGN PRINCIPLES *TRANSLATED* [Mackinlay 1986]

Expressiveness

Tell the truth and nothing but the truth.
(don't lie, and don't lie by omission)

Effectiveness

Use encodings that people decode better.
(where better = faster and/or more accurate)

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EFFECTIVENESS RANKINGS [Mackinlay 1986]

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density (Value)	Color Hue
Angle	Color Sat	Texture
Slope	Color Hue	Connection
Area (Size)	Texture	Containment
Volume	Connection	Density (Value)
Density (Value)	Containment	Color Sat
Color Sat	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area (Size)	Slope
Containment	Volume	Area
Shape	Shape	Volume

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Graphical Perception

The ability of viewers to interpret visual (graphical) encodings of information and thereby decode information in graphs.

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TODAY

Learning Objectives

1. Understand basic features of human visual perception.
2. Understand why some visualizations more perceptually effective than others (i.e., understand graphical perception.).

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SIGNAL DETECTION

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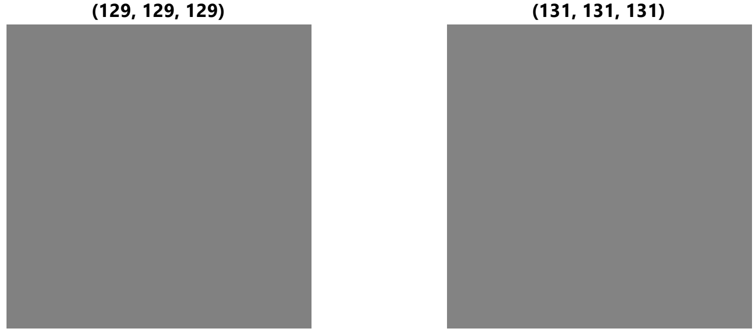
DETECTING BRIGHTNESS

Which is brighter?

12

DETECTING BRIGHTNESS

(129, 129, 129) (131, 131, 131)



Which is brighter?

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JUST NOTICEABLE DIFFERENCE

JND (Weber's Law)

Scale Factor
(Empirically Determined)

Perceived change in Sensation

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

Change of Intensity

Physical Intensity

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JUST NOTICEABLE DIFFERENCE

JND (Weber's Law)

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

Ratios more important than magnitude

Most continuous variations in stimuli are perceived in discrete steps

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ENCODING DATA WITH COLOR

Value is perceived as ordered

∴ Encode ordinal variables (O)

∴ Encode continuous variables (Q) [not as well]

Hue is normally perceived as unordered

∴ Encode nominal variables (N) using color

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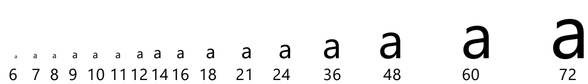
STEPS IN FONT SIZE

Sizes standardized in 16th century



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ESTIMATING MAGNITUDE

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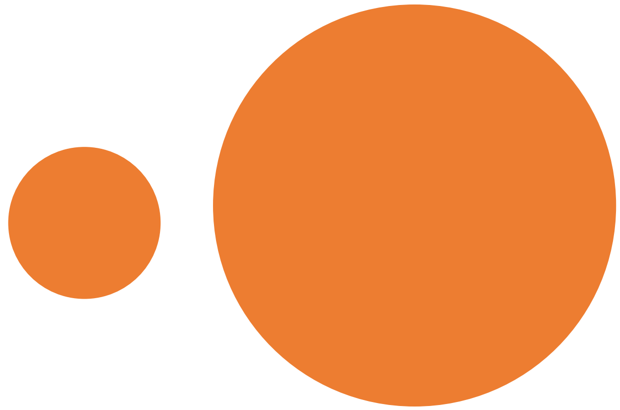

Compare areas of circles

20

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Compare lengths of bars

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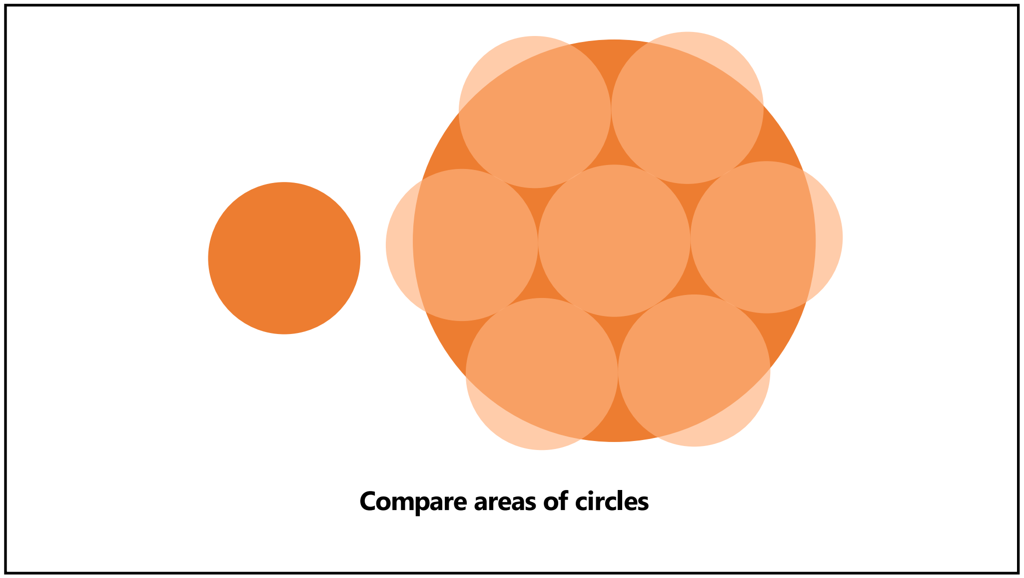

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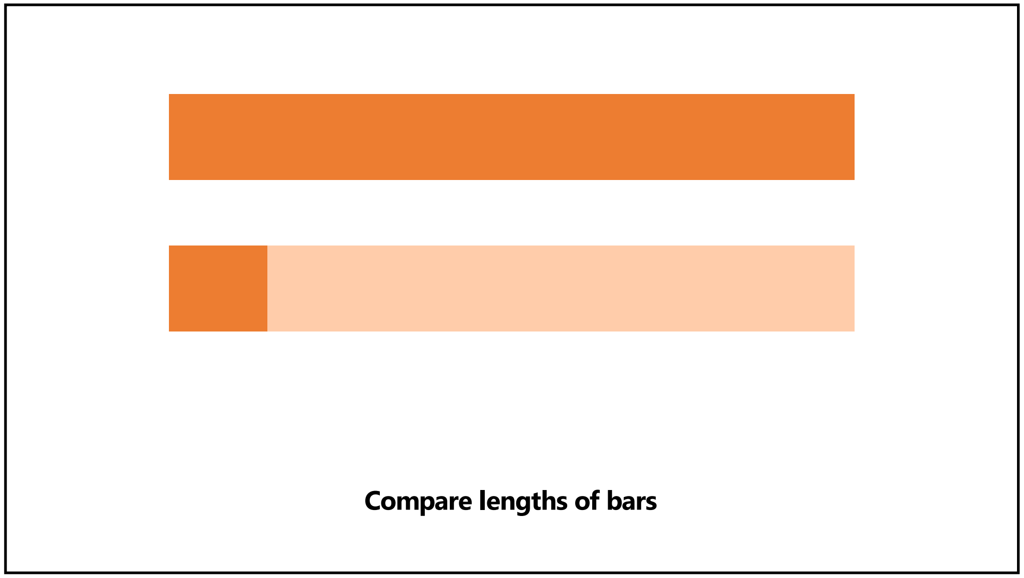

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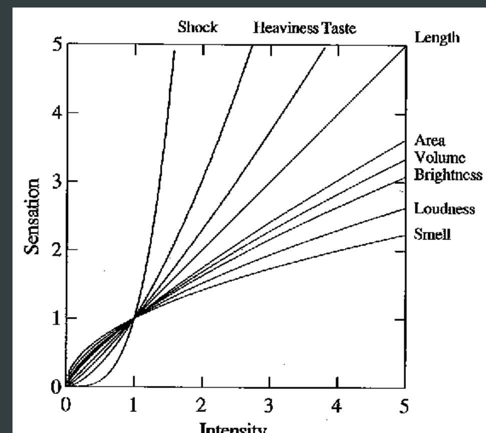
STEPHEN'S POWER LAW

Exponent
(Empirically Determined)

$$S = I^p$$

Perceived Sensation — Physical Intensity

p < 1 : underestimate
p > 1 : overestimate



Graph from Wilkinson 1999, based on Stevens 1961

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EXPONENTS OF POWER LAW

Sensation	Exponent
Loudness	0.6
Brightness	0.33
Smell	0.55 (Coffee) - 0.6 (Heptane)
Taste	0.6 (Saccharine) -1.3 (Salt)
Temperature	1.0 (Cold) – 1.6 (Warm)
Vibration	0.6 (250 Hz) – 0.95 (60 Hz)
Duration	1.1
Pressure	1.1
Heaviness	1.45
Electic Shock	3.5

Psychophysics of Sensory Function [Stevens 1961]

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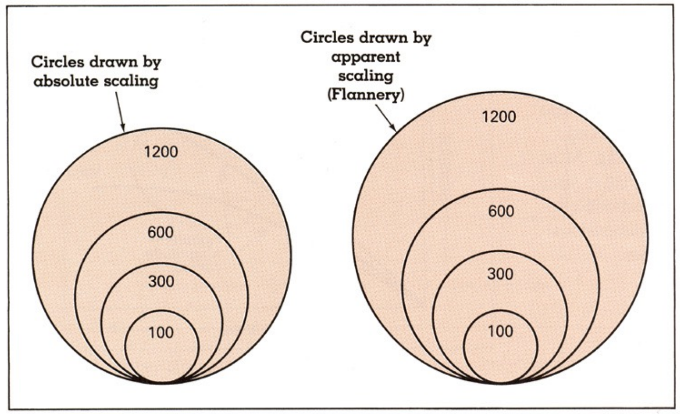
APPARENT MAGNITUDE SCALING



Cartography: Thematic Map Design, Figure 8.6, p. 170, [Dent 1996]

$$r = r_0(\frac{v}{v_0})^{0.5716}$$ [Flannery 1971]

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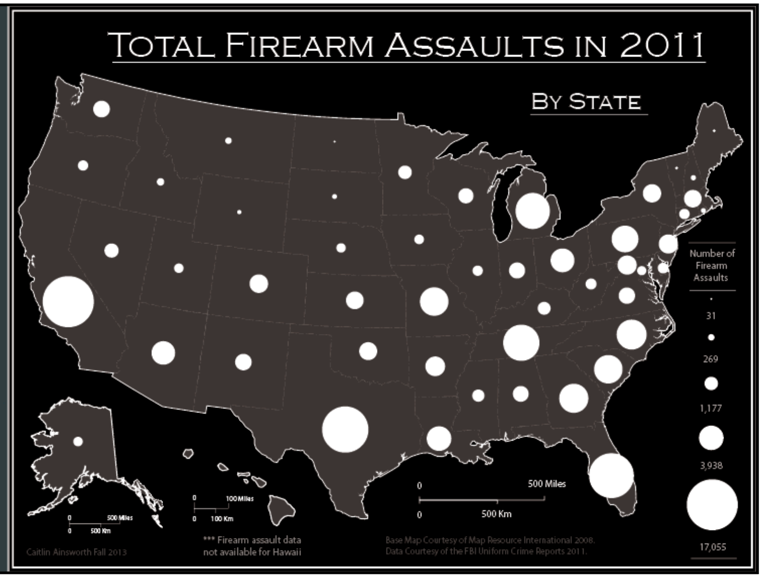
ABSOLUTE SYMBOL SCALING



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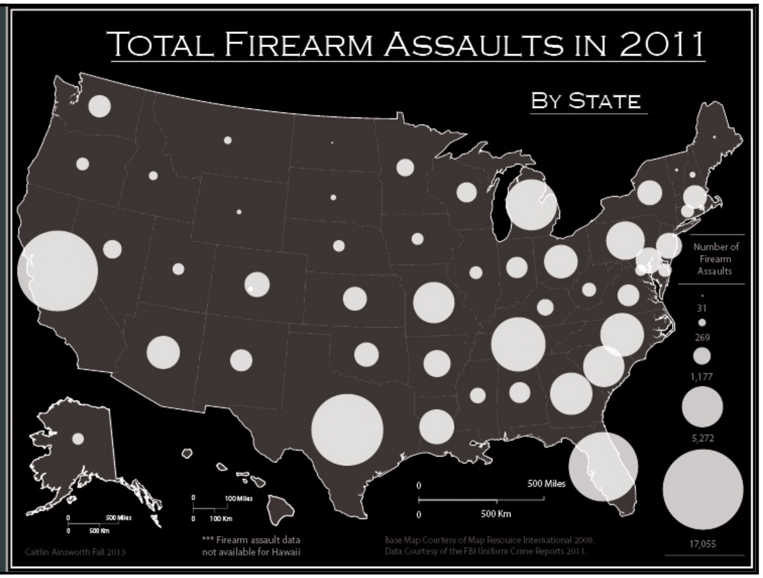
FLANNERY SCALING

$$r = r_0 \left(\frac{v}{v_0}\right)^{0.5716}$$



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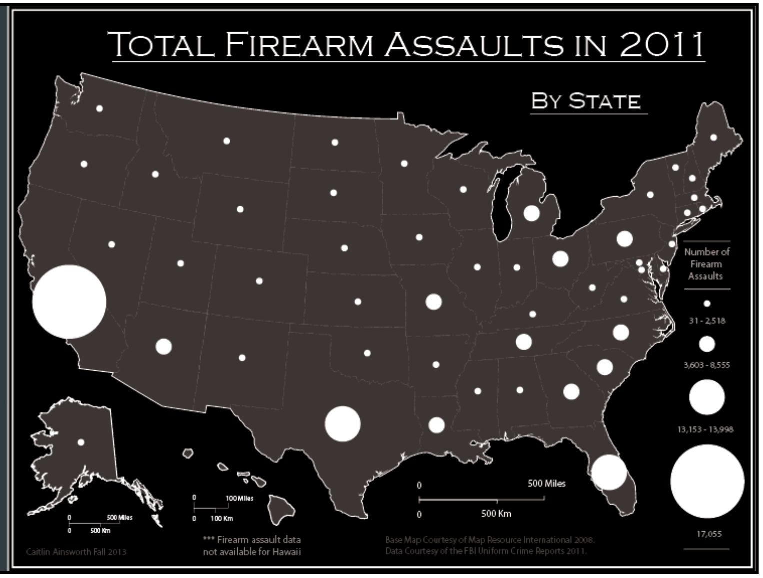
RANGE GRADING



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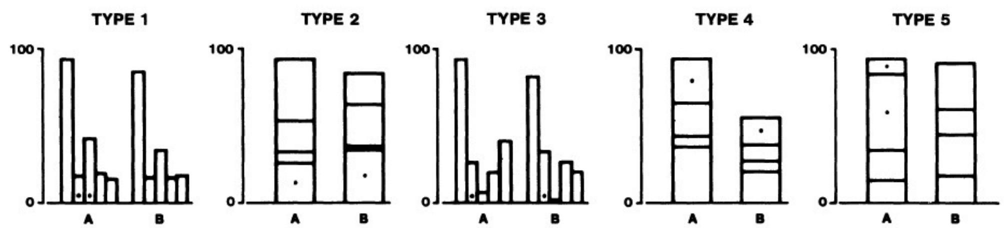

Graphical Perception [Cleveland and McGill 1984]

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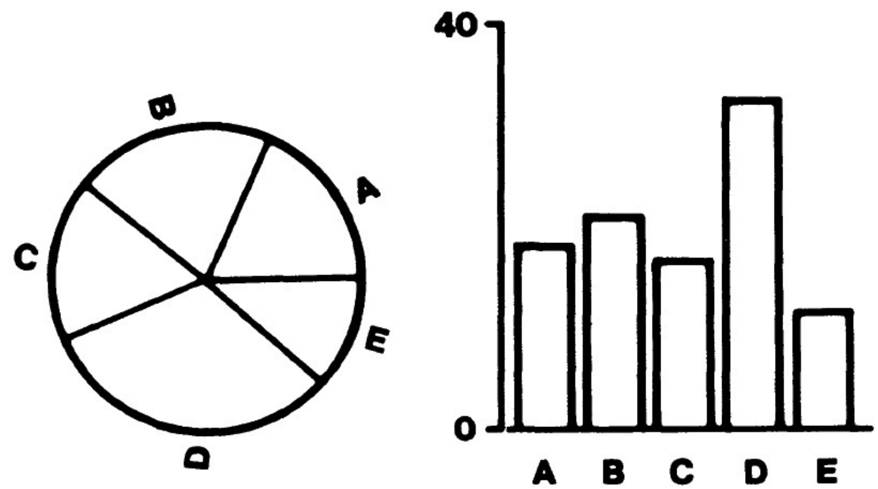

Graphical Perception [Cleveland and McGill 1984]

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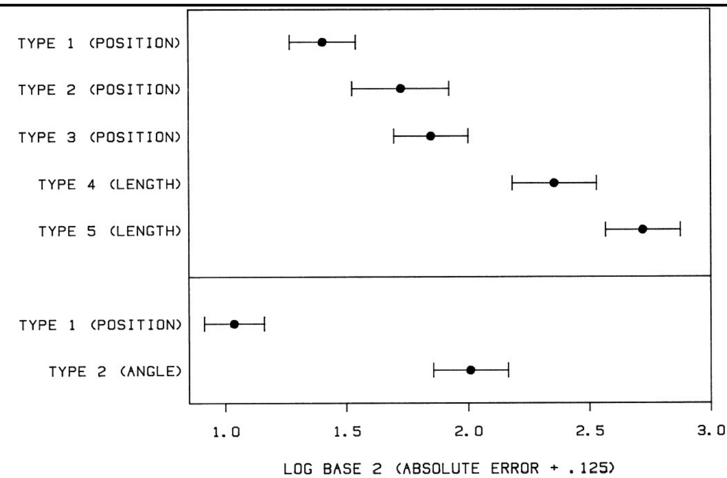

Figure 16. Log absolute error means and 95% confidence intervals for judgment types in position–length experiment (top) and position–angle experiment (bottom).

Graphical Perception [Cleveland and McGill 1984]

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RELATIVE MAGNITUDE ESTIMATION

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EFFECTIVENESS RANKINGS [Mackinlay 1986]

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density (Value)	Color Hue
Angle	Color Sat	Texture
Slope	Color Hue	Connection
Area (Size)	Texture	Containment
Volume	Connection	Density (Value)
Density (Value)	Containment	Color Sat
Color Sat	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area (Size)	Slope
Containment	Volume	Area
Shape	Shape	Volume

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MULTIPLE ATTRIBUTES

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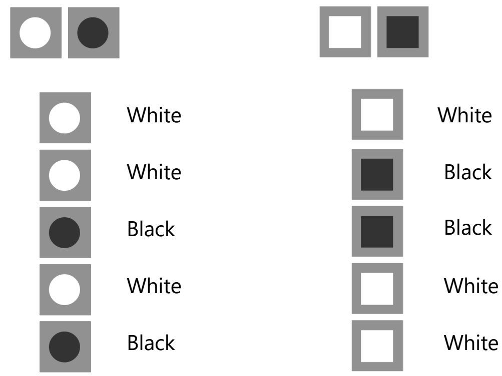
ONE-DIMENSIONAL: LIGHTNESS



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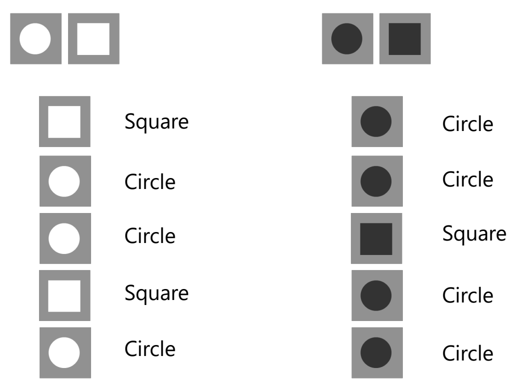
ONE-DIMENSIONAL: SHAPE



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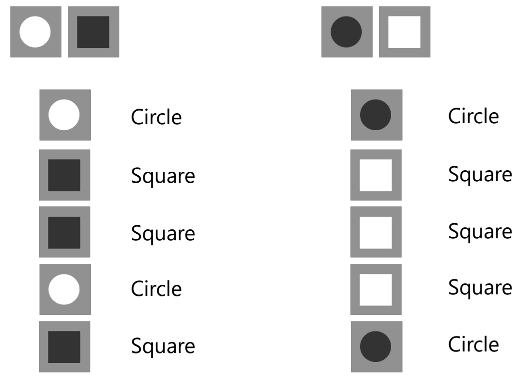
REDUNDANT: SHAPE & LIGHTNESS



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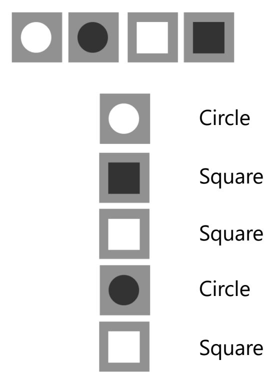
ORTHOGONAL: SHAPE & LIGHTNESS



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SPEEDED CLASSIFICATION

Redundancy gain

Facilitation in reading one dimension when the other provides redundant information

Filtering interference

Difficulty in ignoring one dimension while attending to the other

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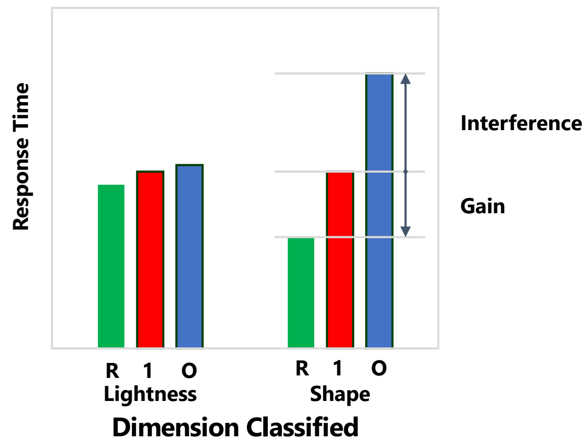
SPEEDED CLASSIFICATION



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TYPES OF PERCEPTUAL DIMENSIONS

Integral
Filtering interference and redundancy gain

Separable
No interference or gain

Configural
Only interference, but no redundancy gain

Asymmetrical
One dimension separable from other, not vice versa
Example: The Stroop effect – color naming is influenced by word identity, but word naming is not influenced by color

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STROOP EFFECT: WHAT WORD?

blue
yellow
red
orange
green
purple

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STROOP EFFECT: WHAT COLOR?

blue
yellow
red
orange
green
purple

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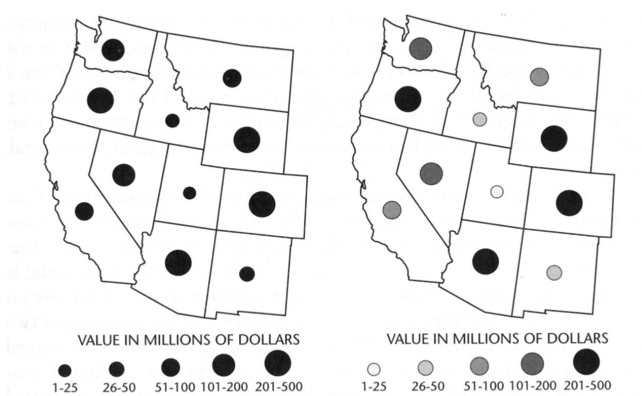
REDUNDANT: SIZE & VALUE



W. S. Dobson, Visual information processing and cartographic communication: The role of redundant stimulus dimensions, 1983 [reprinted in MacEachren, 1995]

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ORTHOGONAL: HEIGHT & WIDTH

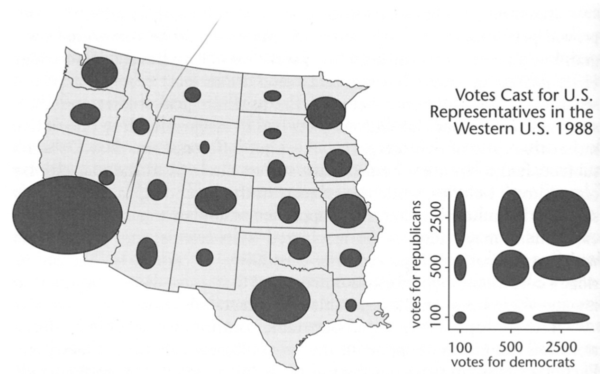

FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

[MacEachren 1995]

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ORTHOGONAL: ORIENTATION & SIZE

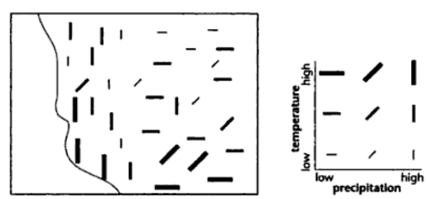

FIGURE 3.36. A map of temperature and precipitation using symbol size and orientation to represent data values on the two variables.

How well can you see temperature or precipitation?
Is there a correlation between the two?

[MacEachren 1995]

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ORTHOGONAL: SHAPE & SIZE

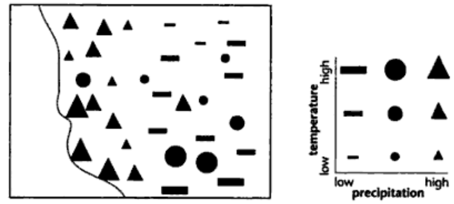

FIGURE 3.40. The bivariate temperature–precipitation map of Figure 3.36, this time using point symbols that vary in shape and size to represent the two quantities.

Easier to see one shape across multiple sizes than one size of across multiple shapes?

[MacEachren 1995]

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SUMMARY OF INTEGRAL-SEPARABLE

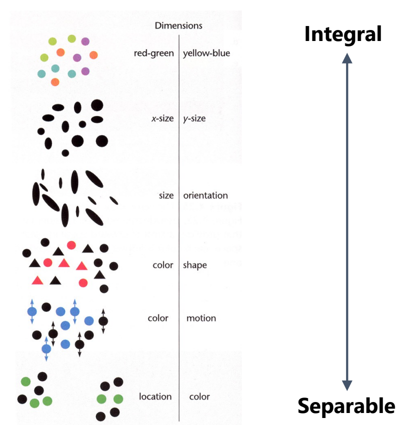

Figure 5.25, Color Plate 10, [Ware 2000]

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PRE-ATTENTIVE VS. ATTENTIVE

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1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

58

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

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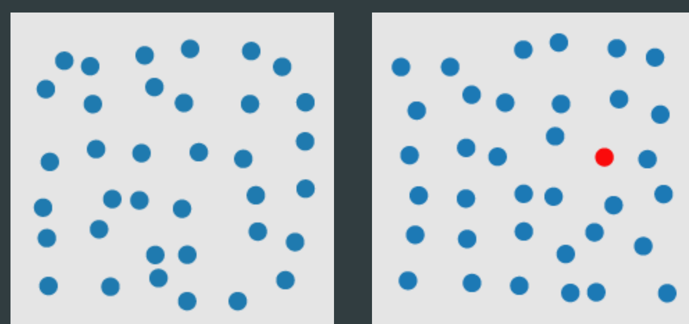
VISUAL POP-OUT: COLOR



https://www.csc2.ncsu.edu/faculty/healey/PP/

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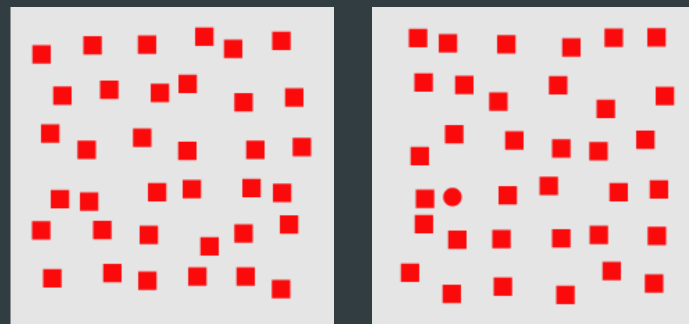
VISUAL POP-OUT: SHAPE



https://www.csc2.ncsu.edu/faculty/healey/PP/

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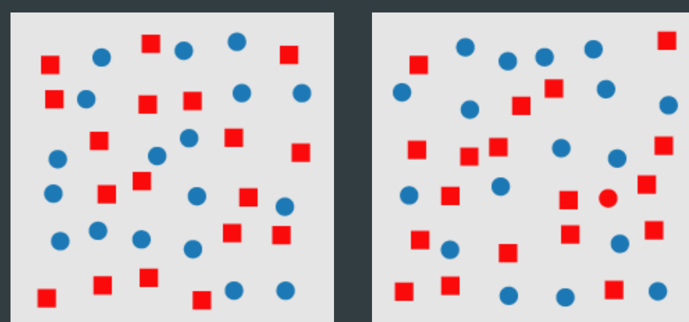
FEATURE CONJUNCTIONS



https://www.csc2.ncsu.edu/faculty/healey/PP/

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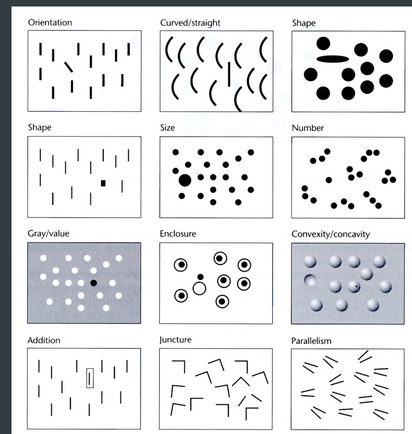
PRE-ATTENTIVE FEATURES



Information Visualization. Figure 5. 5 [Ware 2004]

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MORE PRE-ATTENTIVE FEATURES

Line (blob) orientation	**Julesz & Bergen [1983]; Wolfe et al. [1992]**
Length	**Triesman & Gormican [1988]**
Width	**Julesz [1985]**
Size	**Triesman & Gelade [1980]**
Curvature	**Triesman & Gormican [1988]**
Number	**Julesz [1985]; Trick & Pylyshyn [1994]**
Terminators	**Julesz & Bergen [1983]**
Intersection	**Julesz & Bergen [1983]**
Closure	**Enns [1986]; Triesman & Souther [1985]**
Colour (hue)	**Nagy & Sanchez [1990, 1992]; D'Zmura [1991]; Kawai et al. [1995]; Bauer et al. [1996]**
Intensity	**Beck et al. [1983]; Triesman & Gormican [1988]**
Flicker	**Julesz [1971]**
Direction of motion	**Nakayama & Silverman [1986]; Driver & McLeod [1992]**
Binocular lustre	**Wolfe & Franzel [1988]**
Stereoscopic depth	**Nakayama & Silverman [1986]**
3-D depth cues	**Enns [1990]**
Lighting direction	**Enns [1990]**

http://www.csc.ncsu.edu/faculty/healey/PP/index.html

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PRE-ATTENTIVE CONJUNCTIONS

Spatial conjunctions are often pre-attentive

Motion and 3D disparity

Motion and color

Motion and shape

3D disparity and color

3D disparity and shape

Most conjunctions are **NOT** preattentive

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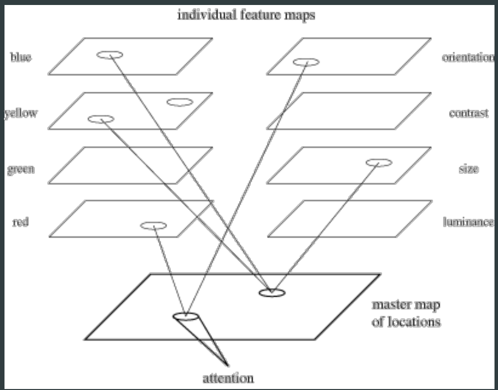
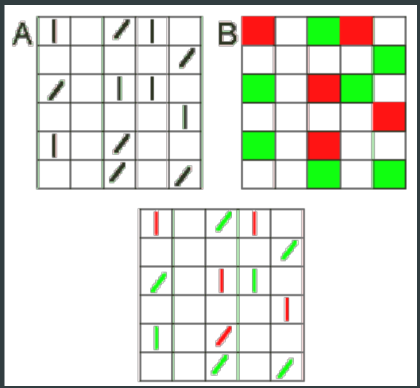
FEATURE INTEGRATION THEORY



Treisman's feature integration model [Healey 2004]



Feature maps for orientation & color

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ANNOUNCEMENTS

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ASSIGNMENT 3: INTERACTION

Due 10/30 11:30am

Create a small interactive dynamic query application similar to HomeFinder, but for local software companies data.

1. Implement interface
2. Submit the application as a website and a short write-up on canvas

Can work alone or in pairs

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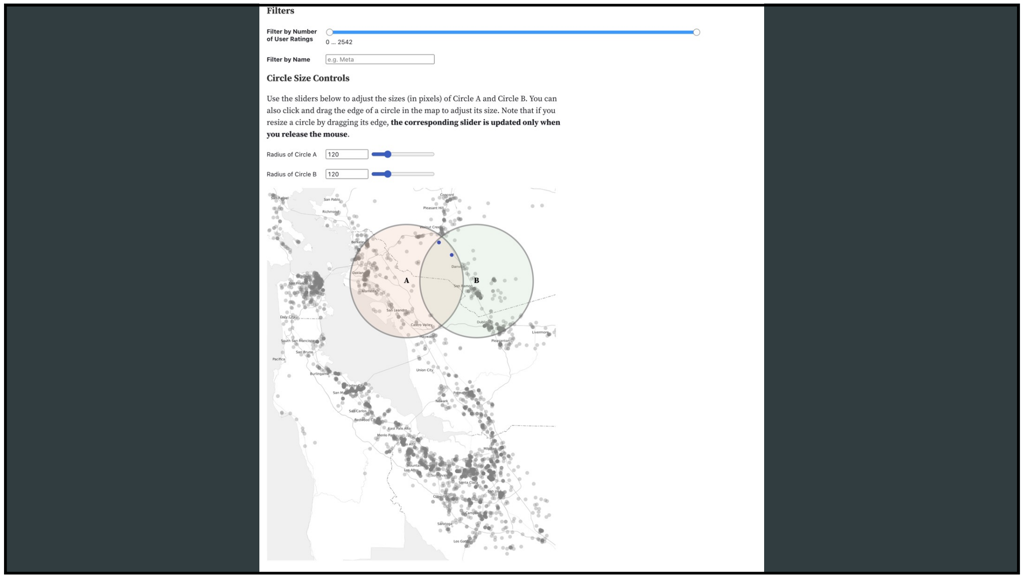
Filters
Filter by Number of User Ratings
0 ... 2542
Filter by Name
e.g. Meta
Circle Size Controls
Use the sliders below to adjust the sizes (in pixels) of Circle A and Circle B. You can also click and drag the edge of a circle in the map to adjust its size. Note that if you resize a circle by dragging its edge, the corresponding slider is updated only when you release the mouse.
Radius of Circle A
120
Radius of Circle B
120
A
B

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