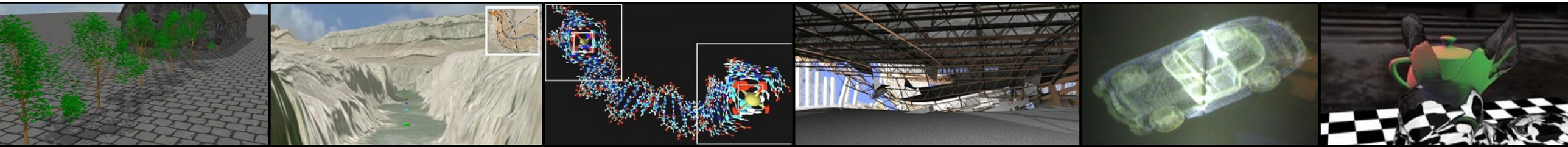
CIS 4930/6930-002
DATA VISUALIZATION

VISUAL ENCODING

Paul Rosen
Assistant Professor
University of South Florida

slides credits Miriah Meyer (U of Utah)



VISUAL ENCODING

marks and channels

planar position

time

color

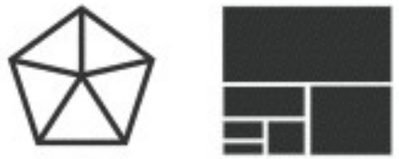
MARKS

graphical element in an image

classified according to number of spatial dimensions required

points (0D)

lines (1D)



areas (2D)

MARKS

marks as nodes (items)

points (0D)

lines (1D)

areas (2D)

marks as links

containment

connection

CHANNELS

parameters that control the appearance of marks

Position

- Horizontal
- Vertical
- Both

Color

Shape

Tilt

Size

- Length
- Area
- Volume

NAME THAT MARK AND CHANNEL

CHANNEL TYPES

identity (what or where)
magnitude (how much)

Position

- Horizontal
- Vertical
- Both

Color

Shape

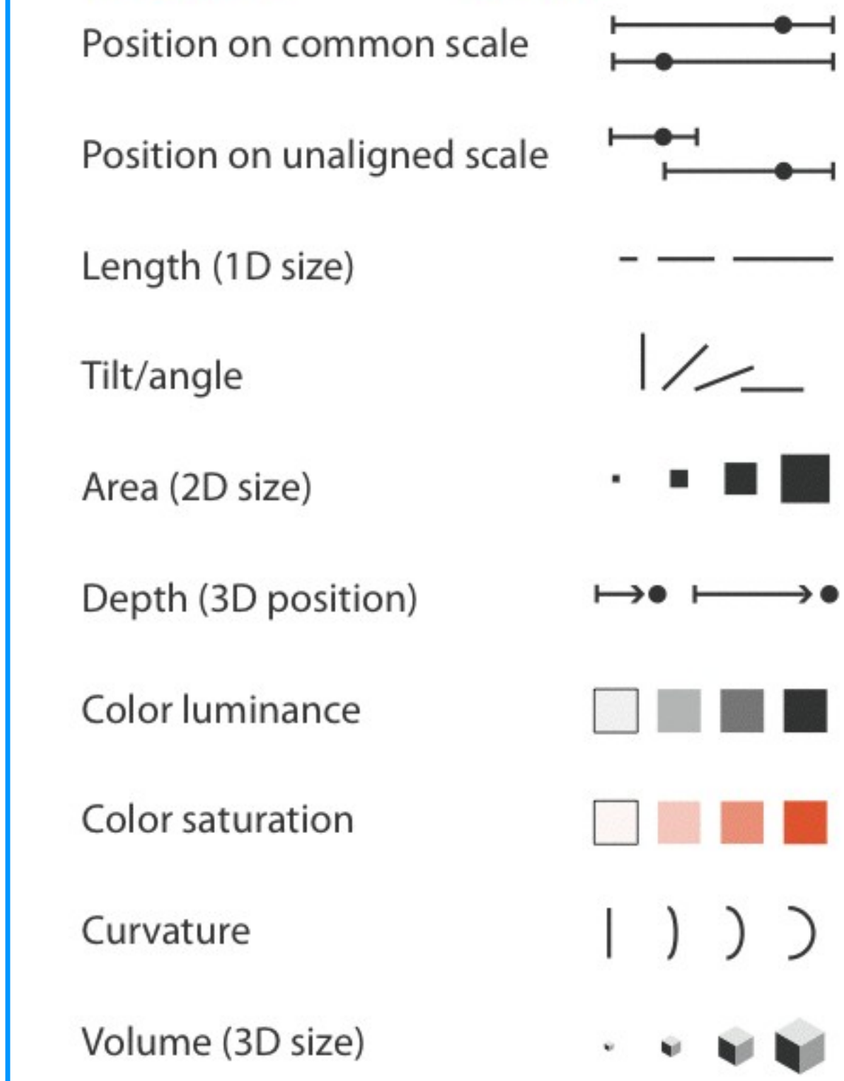
Tilt

Size

- Length
- Area
- Volume

EXPRESSIVENESS & EFFECTIVENESS

Magnitude Channels: Ordered Attributes

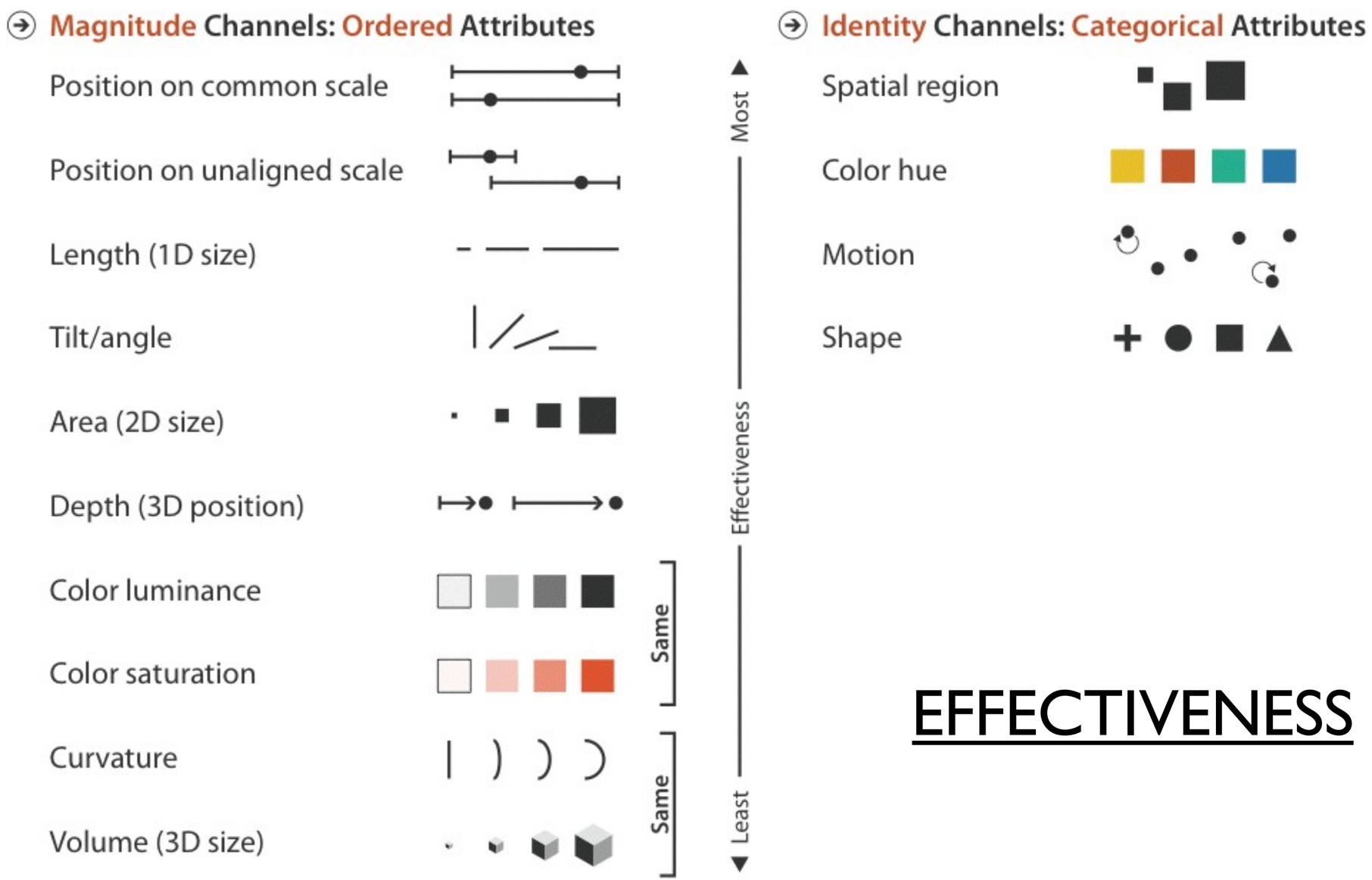


(how much)

Identity Channels: Categorical Attributes

(what or where)

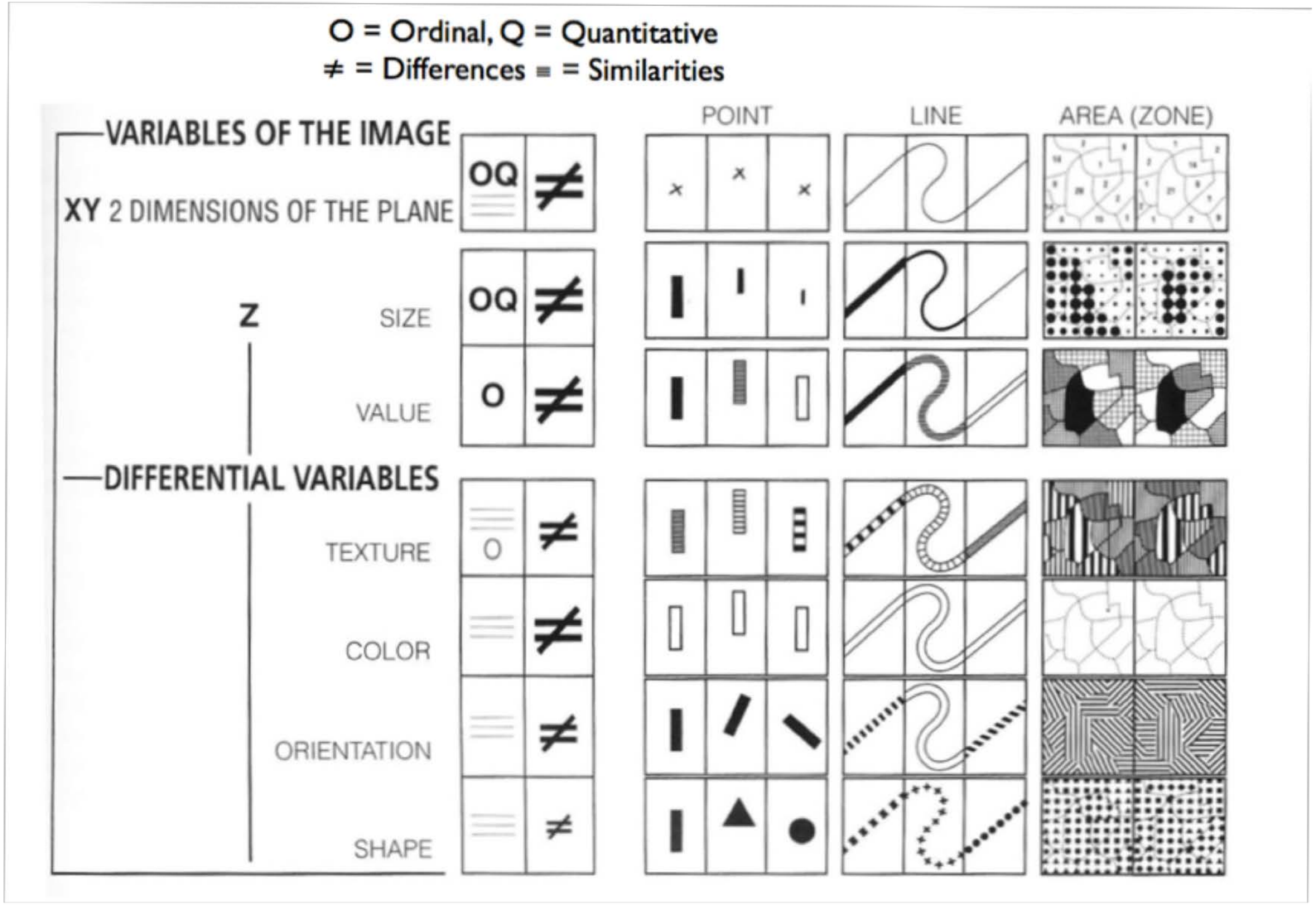
EXPRESSIVENESS



EFFECTIVENESS

WHERE DO RANKINGS COME FROM?

BERTIN, "SEMIOLOGY OF GRAPHICS", 1967



Cleveland & McGill, "Graphical Perception and Graphical Methods for Analyzing Scientific Data", 1985

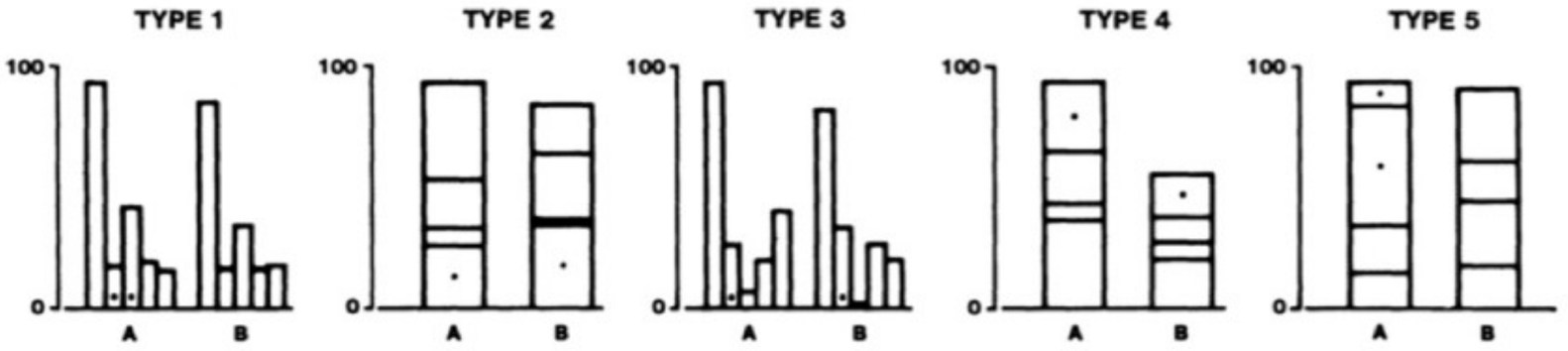


Figure 4. Graphs from position–length experiment.

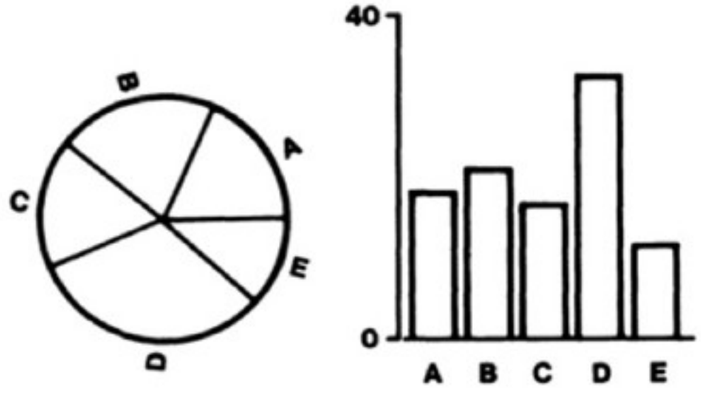
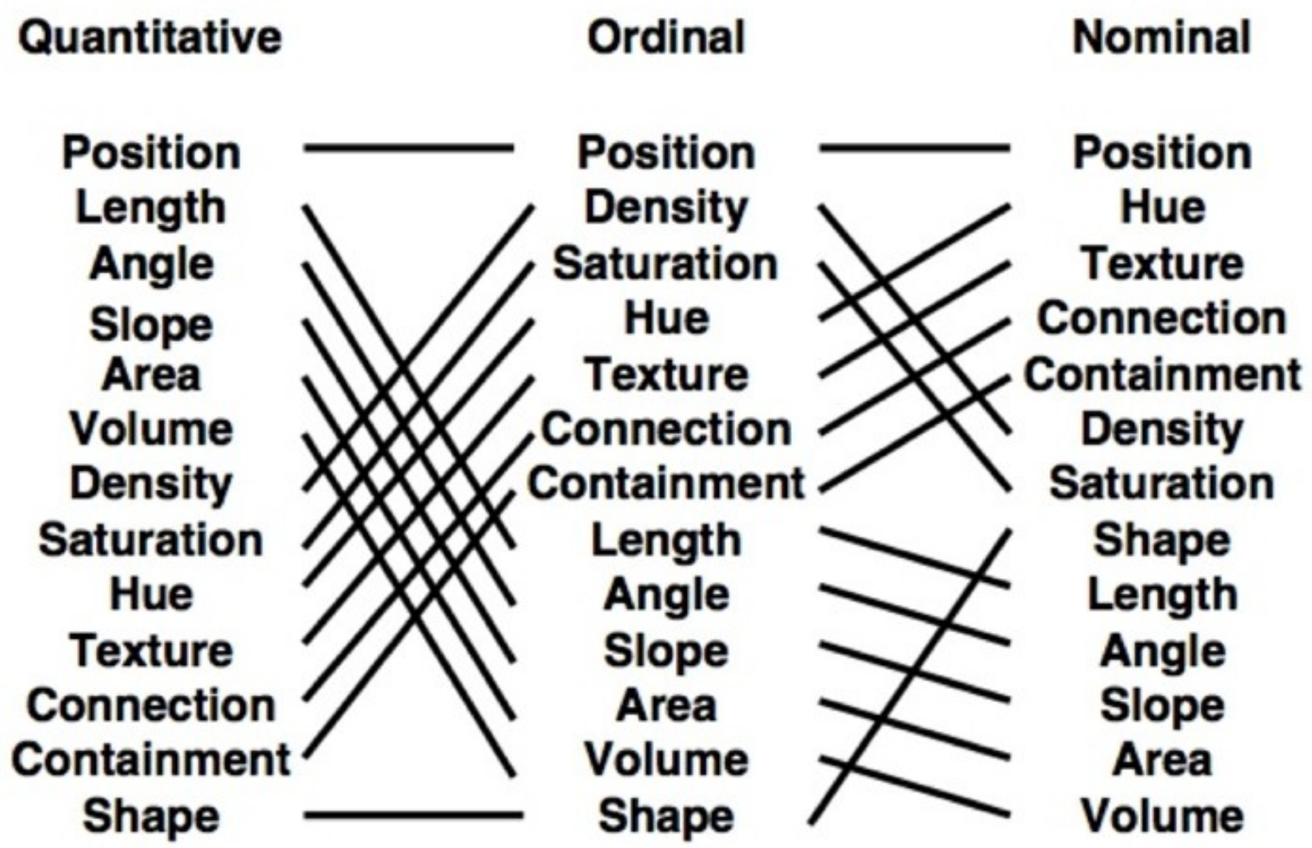


Figure 3. Graphs from position–angle experiment.

MACKINLAY, "AUTOMATING THE DESIGN OF GRAPHICAL PRESENTATIONS OF RELATIONAL INFORMATION", 1986



Heer & Bostock, "Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design", 2010

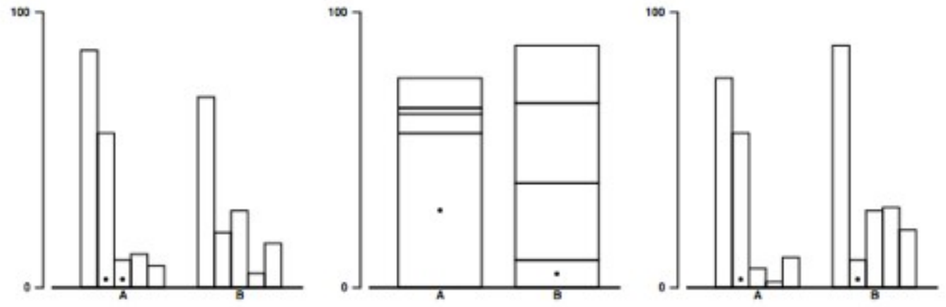


Figure 1: Stimuli for judgment tasks T1, T2 & T3. Subjects estimated percent differences between elements.

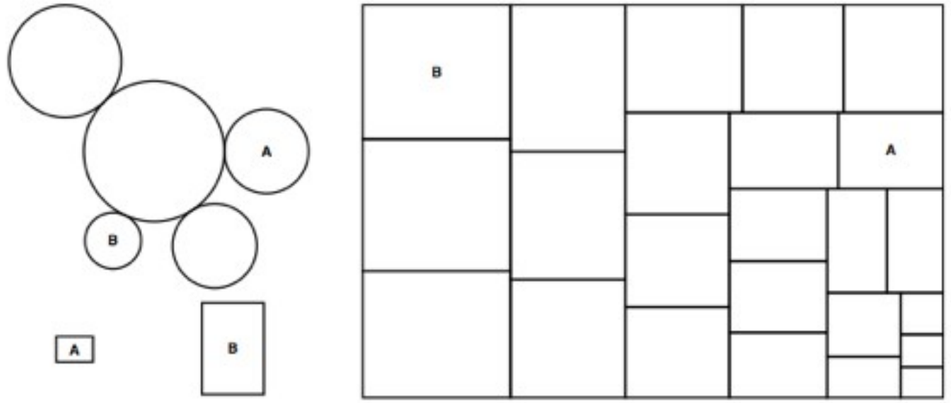
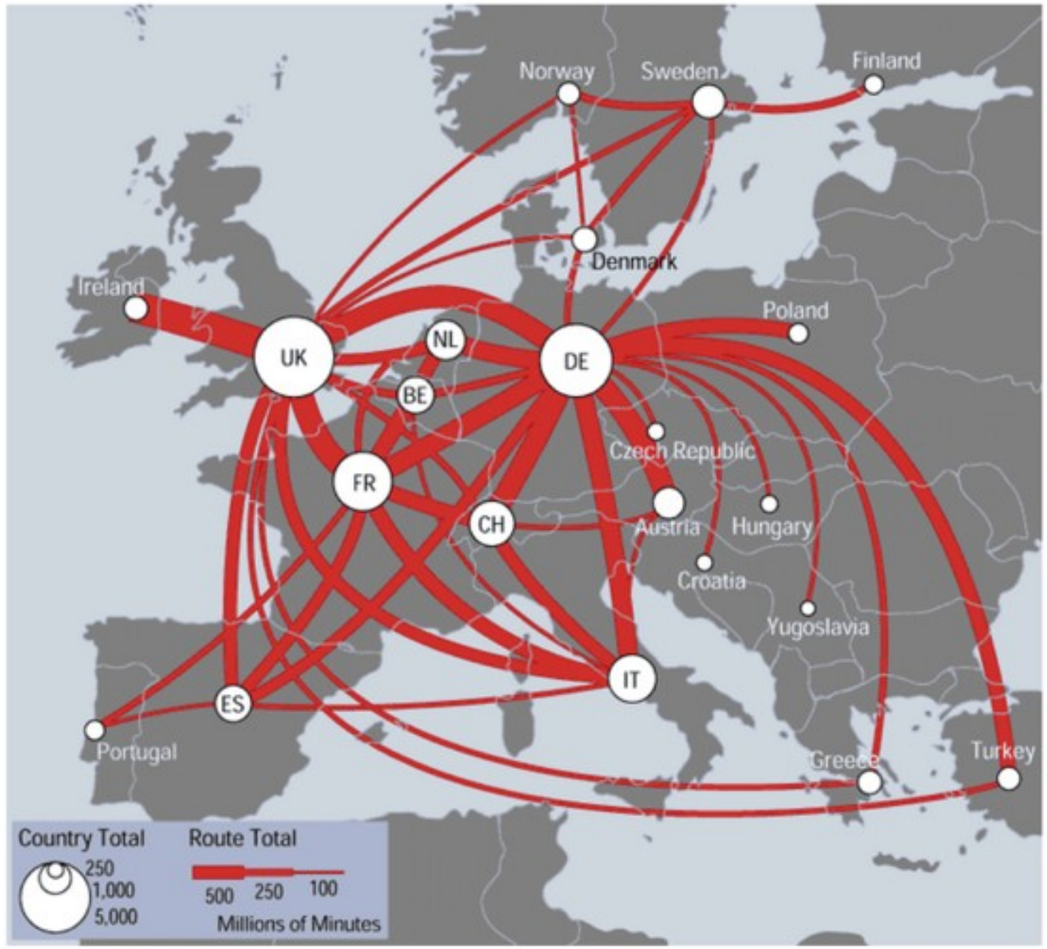


Figure 2: Area judgment stimuli. Top left: Bubble chart (T7), Bottom left: Center-aligned rectangles (T8), Right: Treemap (T9).

DISCRIMINABILITY

can channel differences be discerned?

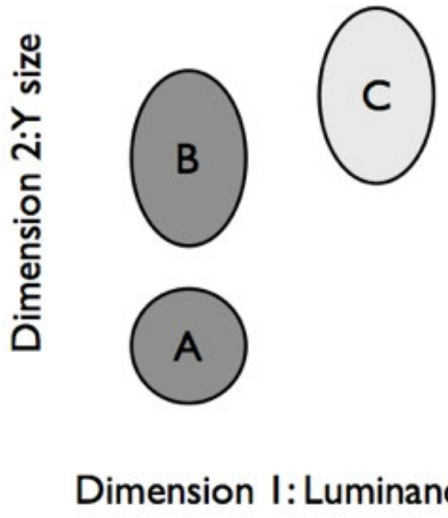


SEPARABLE VS INTEGRAL

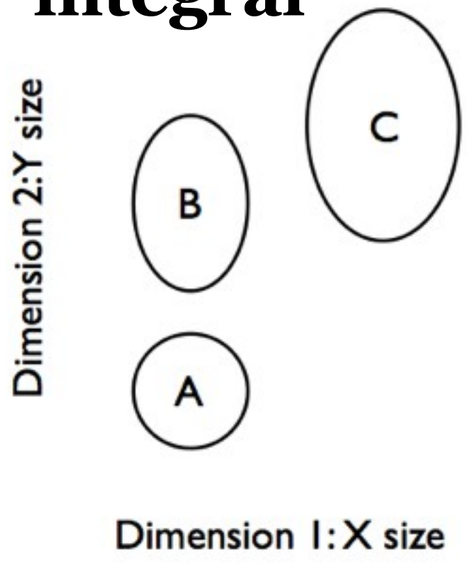
separable: can judge each channel individually

integral: two channels are viewed holistically

separable



integral



WARE 2004

SEPARABLE vs INTEGRAL

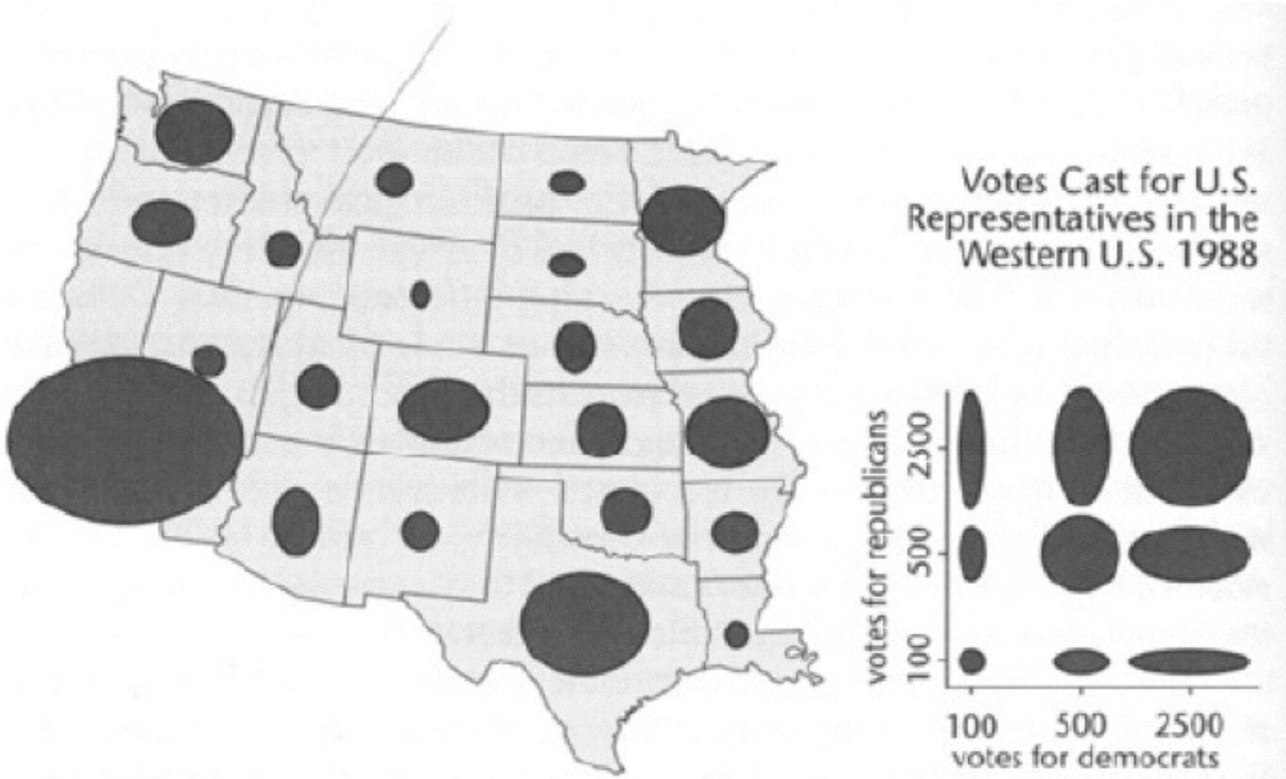


FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

MacEachren 1995

SEPARABLE vs INTEGRAL

separable ⟷ integral

color | location

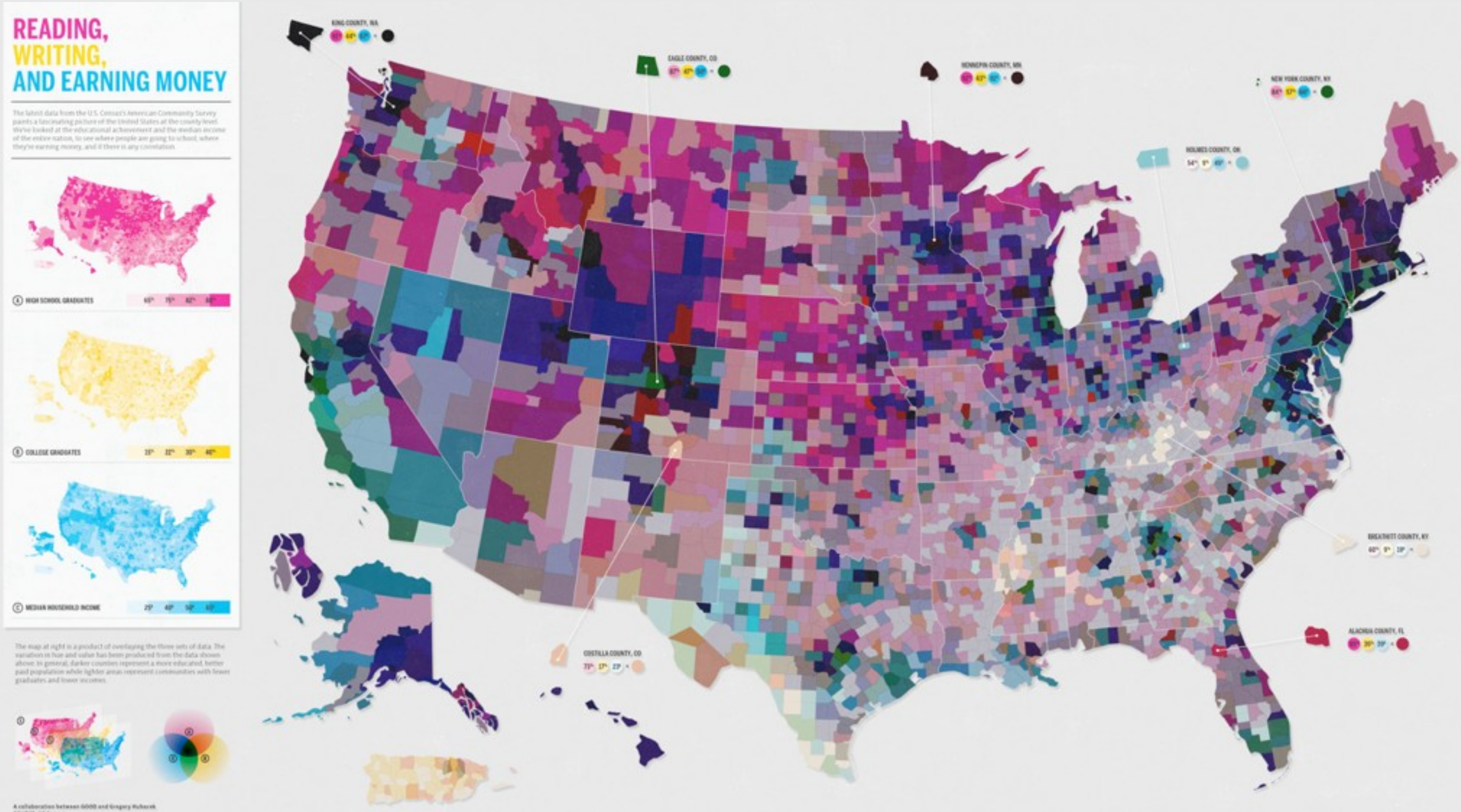
color | shape

x-size | y-size

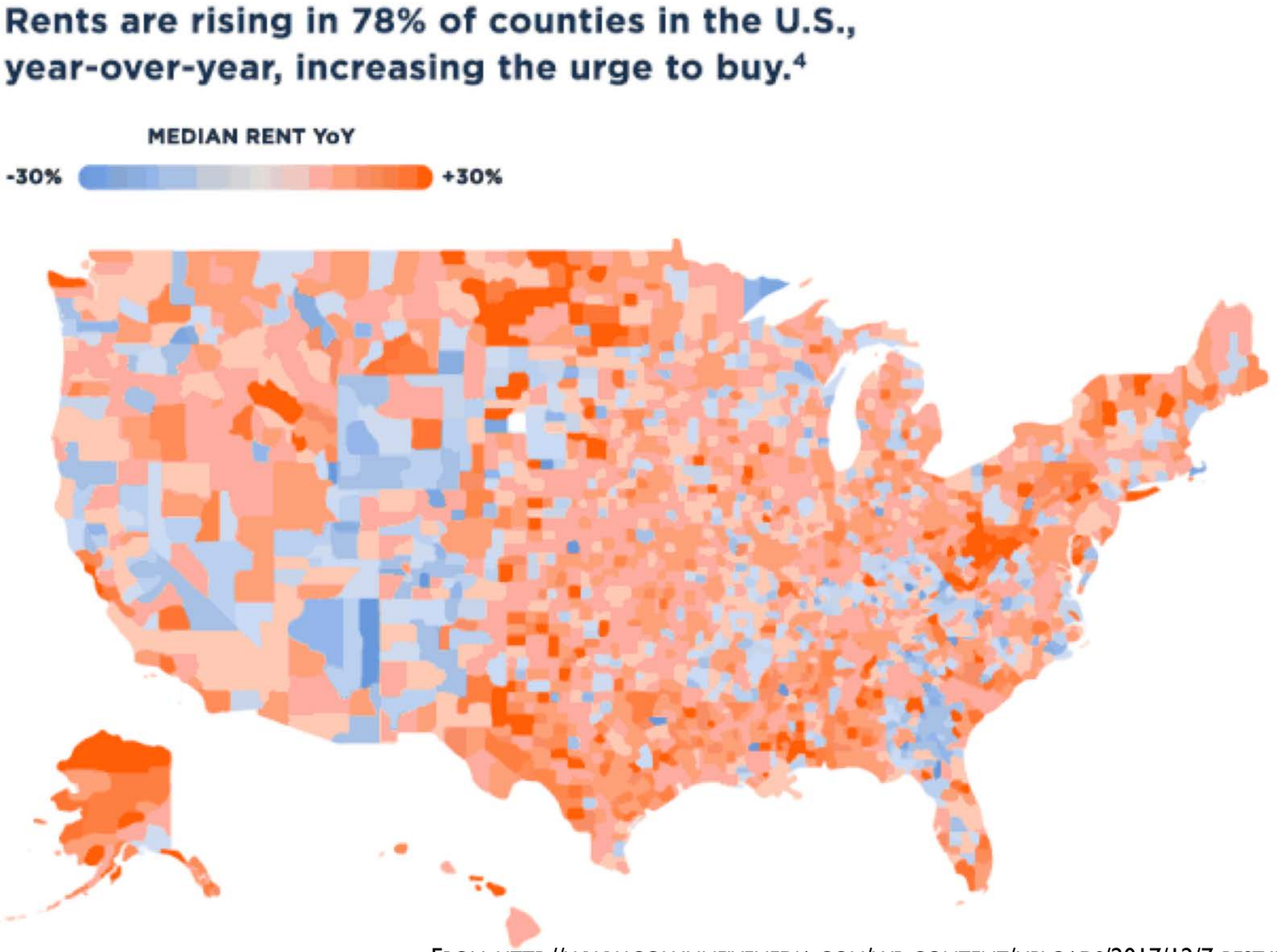
color | motion

size | orientation

red-green | yellow-blue



http://www.good.is/post/america-s-richest-counties-and-best-educated-counties/



FROM: HTTP://WWW.COLUMNFIVEMEDIA.COM/WP-CONTENT/UPLOADS/2017/12/7-BEST-INFOGRAPHIC-DESIGN-2017..GIF

ENCODING SEMANTICS

Graphical Code	Semantics
Small shapes defined by closed contour, texture, color, shaded solid.	Object, idea, entity, node.
Spatially ordered graphical objects.	Related information or a sequence. In a sequence the left-to-right ordering convention borrows from the western convention for written language.
Graphical objects in proximity.	Similar concepts, related information.
Graphical objects having the same shape, color, or texture.	Similar concepts, related information.
Size of graphical object Height of graphical object.	Magnitude, quantity, importance.
Shapes connected by contour.	Related entities, path between entities.
Thickness of connecting contour.	Strength of relationship.
Color and texture of connecting contour.	Type of relationship.
Shapes enclosed by a contour, or a common texture, or a common color.	Contained entities. Related entities.
Nested regions, partitioned regions.	Hierarchical concepts.
Attached shapes.	Parts of a conceptual structure.

WARE 2010

+ PERCEPTUAL EFFECTS WE WILL DISCUSS NEXT LECTURE

pop-out

steven's power law

weber's law

gestalt principles

PLANAR POSITION

what‘s so special about the plane?

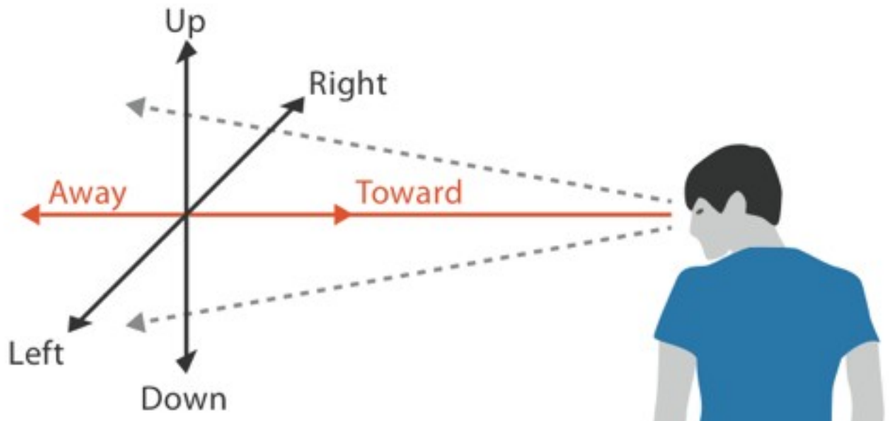
Magnitude Channels: Ordered Attributes

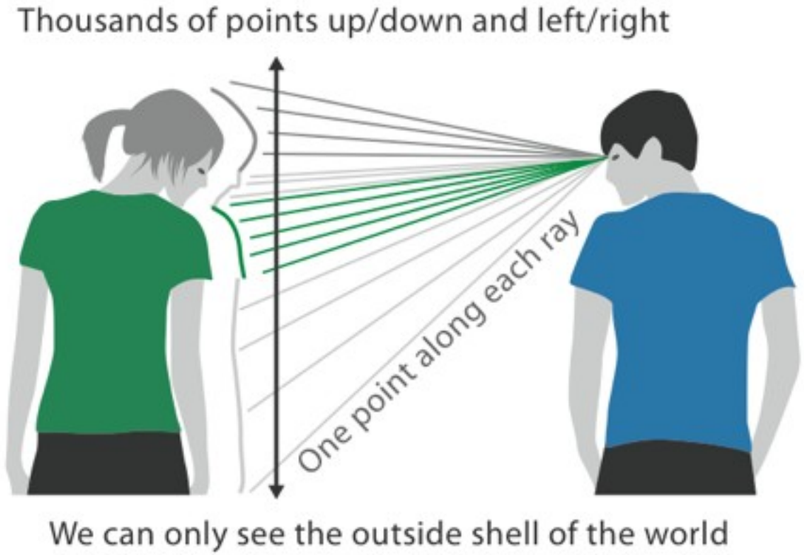
- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

WE SEE THE WORLD AS A ~~2.5D~~ 2.05D SPACE





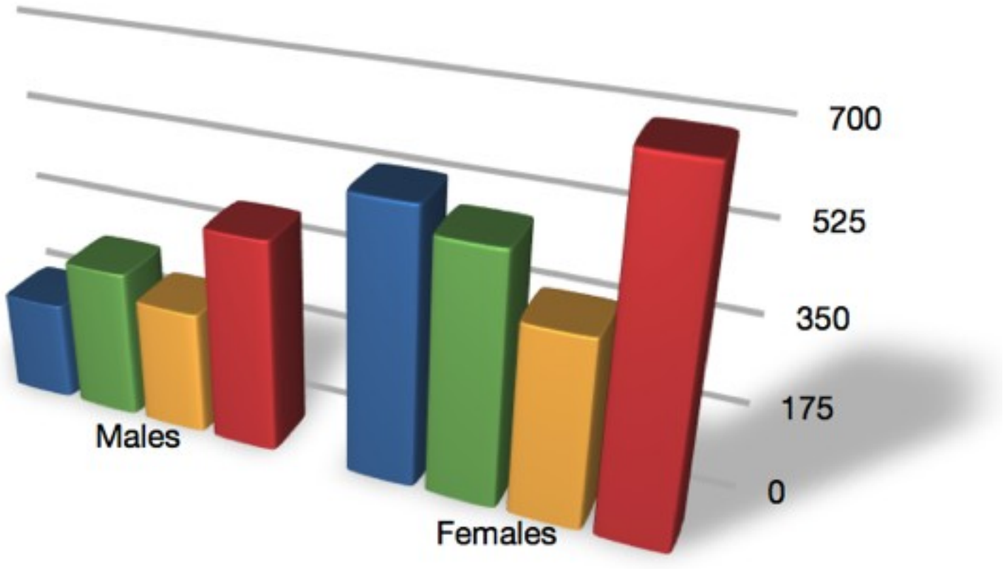
POWER DOES NOT EXTEND TO 3D

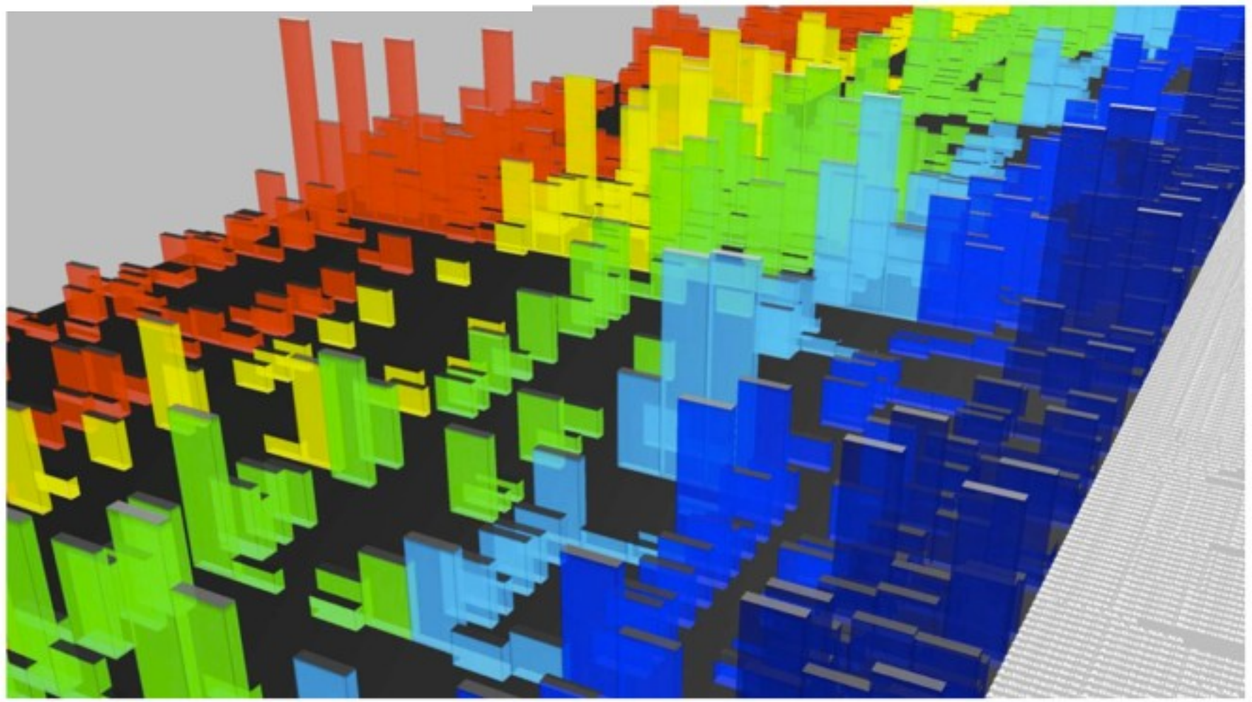
perspective cues

interfere with color and size channels

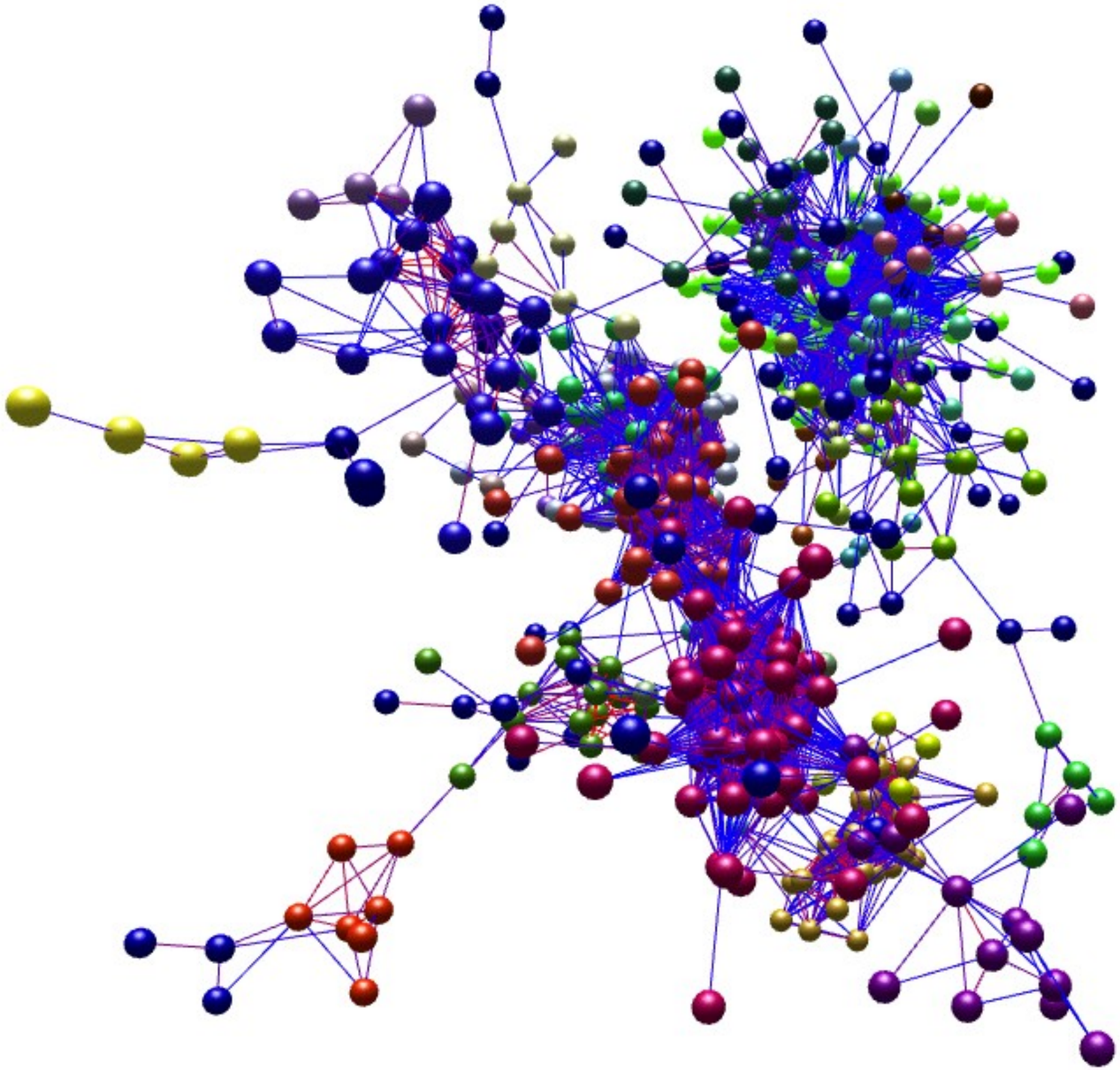
occlusion of data

text legibility





MOORE 2011



HTTP://WWW.BIOLAYOUT.ORG/

TIME AS ENCODING CHANNEL

You'll remember, visualization uses pictures to enhance working memory

external versus internal memory

easy to compare views by moving eyes

hard to compare view to memory of what you saw

ComParrot

by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

ComParrot
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

ComParrot by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

Solution: 1. Top tree leaf removed. 2. Nose line on left giraffe removed. 3. Shadow on lower left coconut removed. 4. Leaf vein below gecko removed. 5. Ear line on left giraffe removed. 6. Bottom spot on right giraffe colored in. 7. Small leaf at right of tree colored in. 8. Horn on right giraffe moved. 9. Spot on left giraffe moved. 10. Branch on left side shorter. 11. Gecko tail longer. 12. Gecko eye missing.

ComParrot

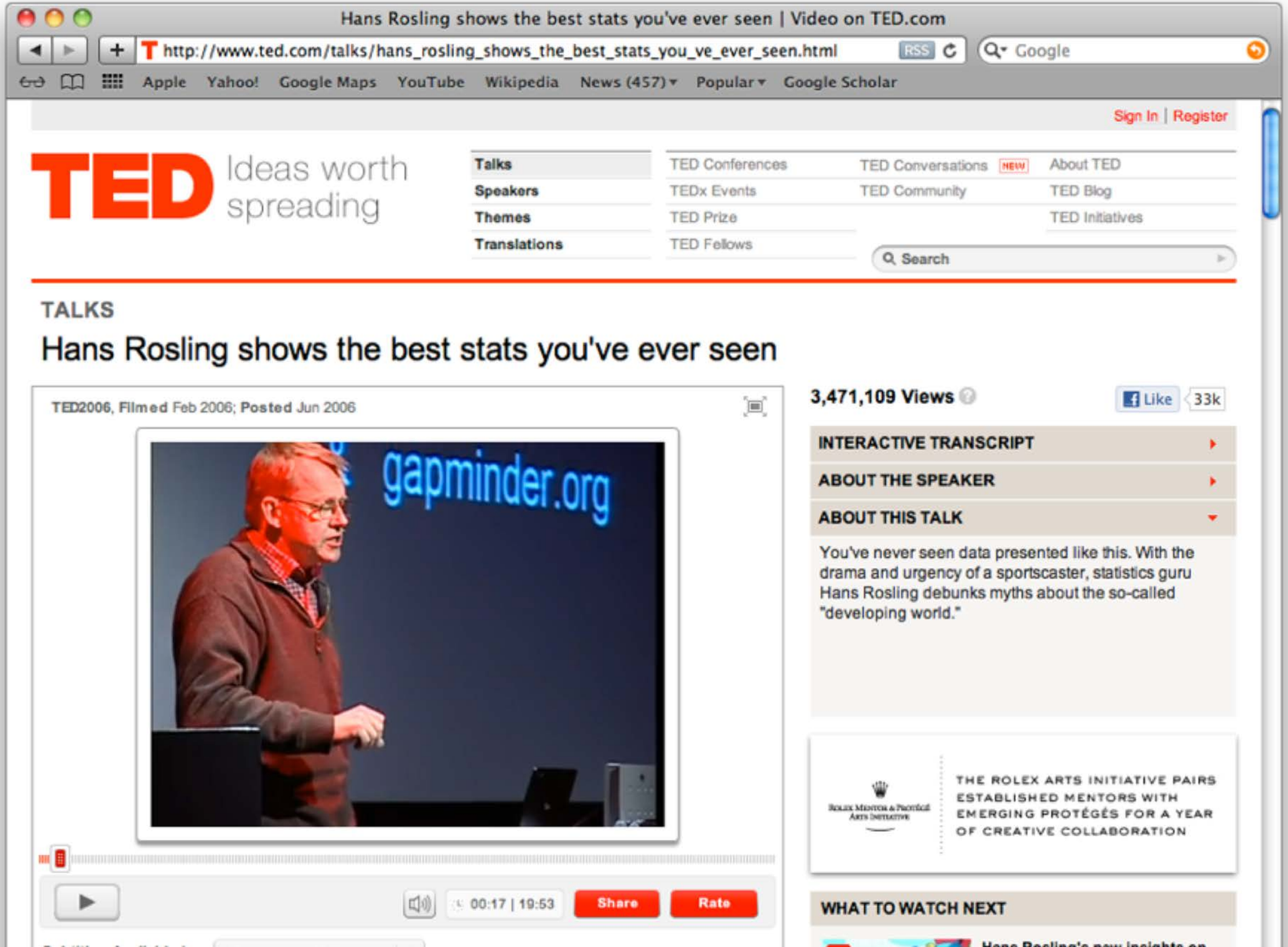
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

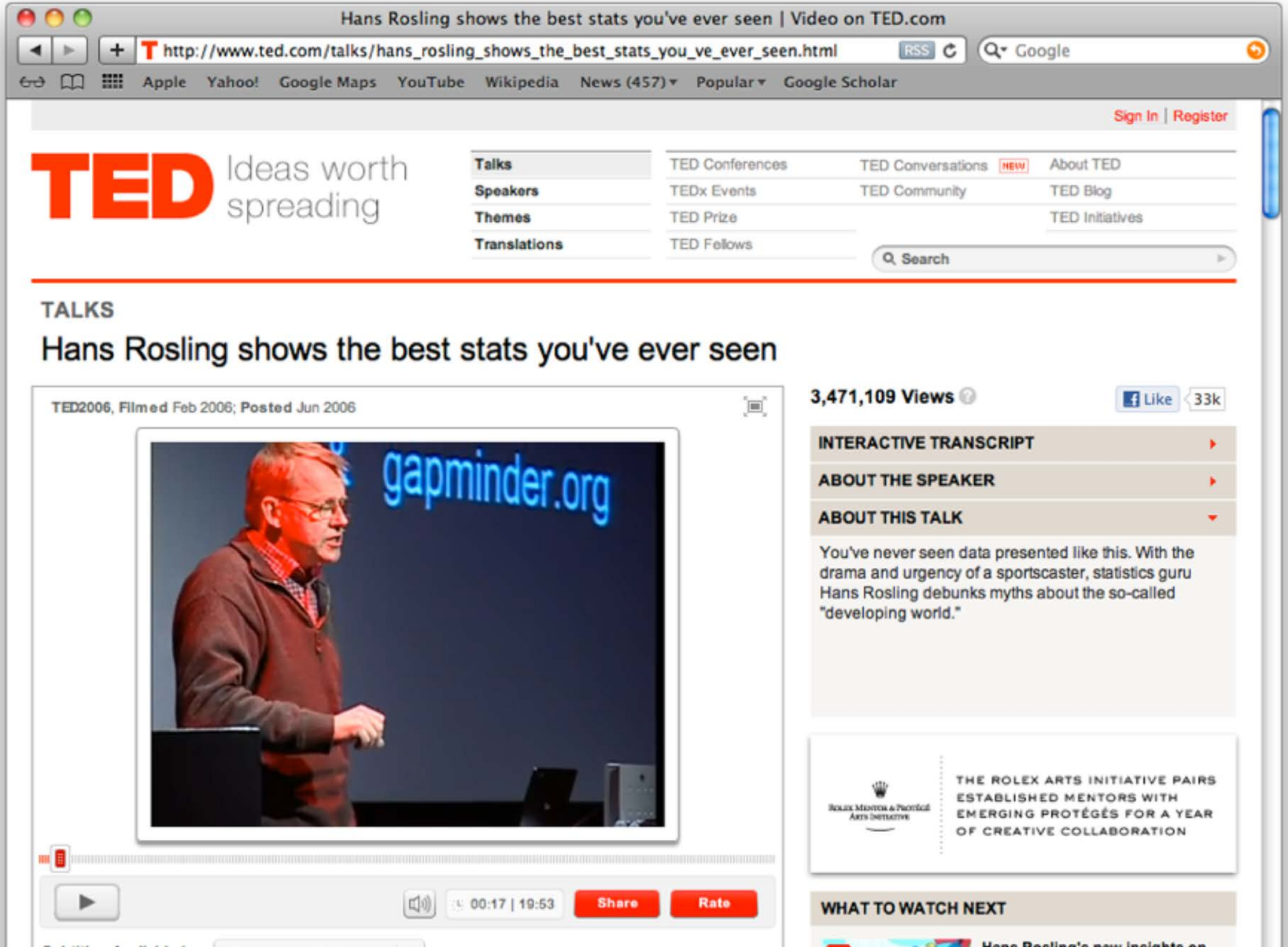
Solution: 1. Top tree leaf removed. 2 removed. 4. Leaf vein below gecko removed. 5. Ear line on left giraffe re of tree colored in. 6. Horn on right giraffe moved. 8. Spot on left giraffe m ye missing.

WHEN TO USE ANIMATION?

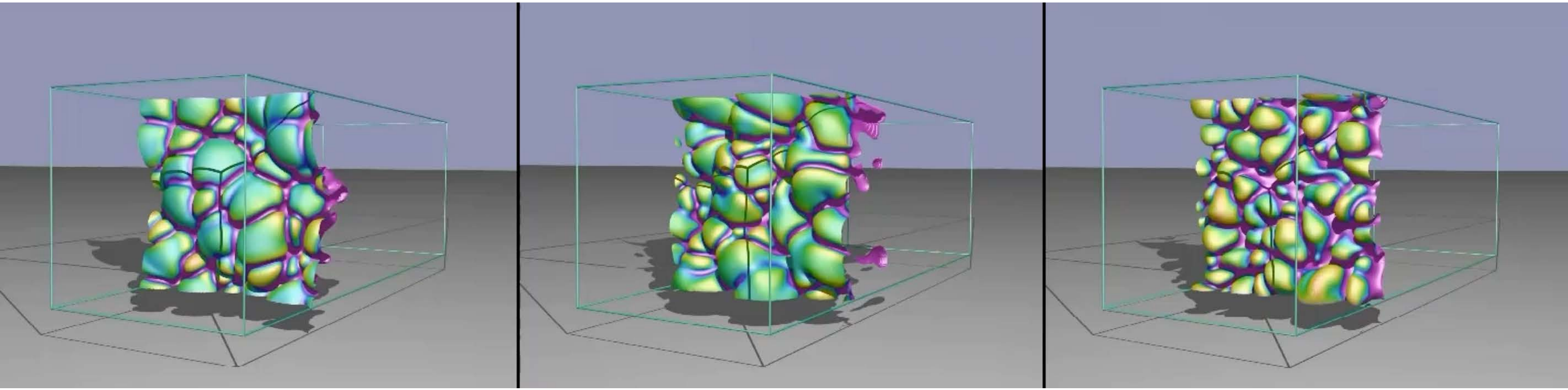
GOOD: STORYTELLING



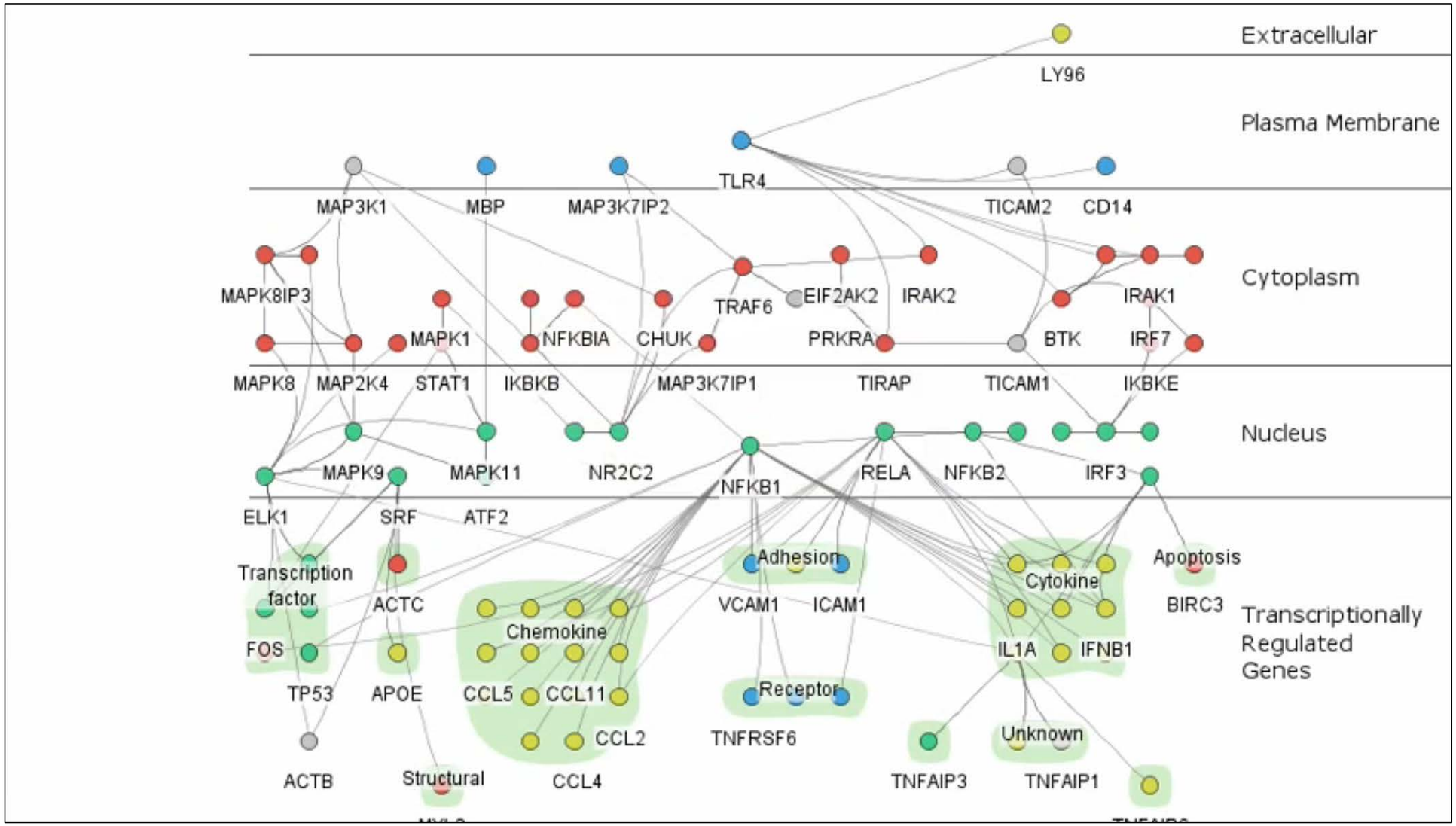
GOOD: TRANSITIONS



BAD: COMPARING COMPLEX STATE CHANGES OVER TIME

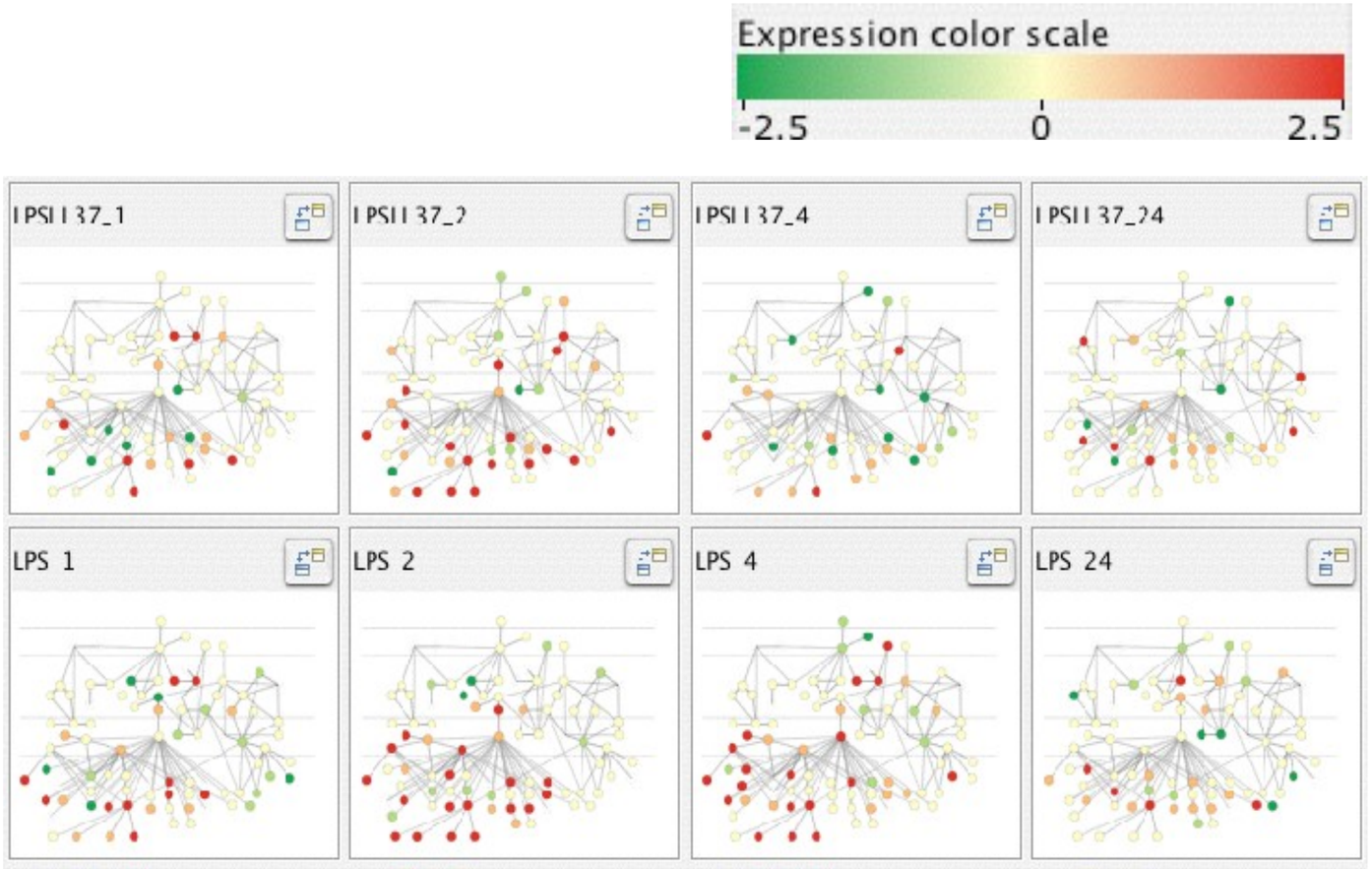


BAD: MULTIPLE STATES WITH MULTIPLE CHANGES



BAD: MULTIPLE STATES WITH MULTIPLE CHANGES

alternative: small multiples



COLOR WILL BE DISCUSSED IN NEXT LECTURE

However, a good mantra is:
"Get it right in black and white" – Maureen Stone

Recommended Reading

Visualization Analysis & Design: Chapter 2 (pp. 20-41)
& Chapter 5 (pp. 94-115)