

CIS 4930/6930-002

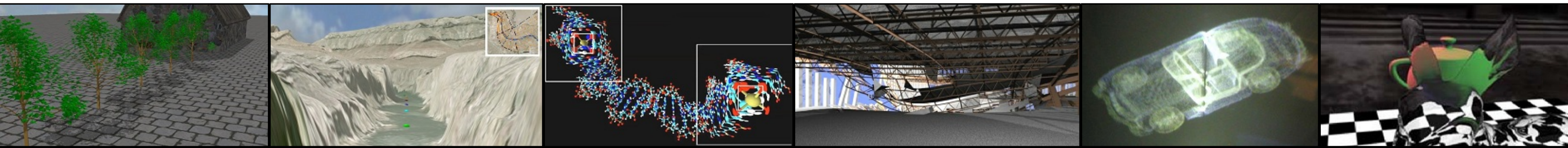
DATA VISUALIZATION



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

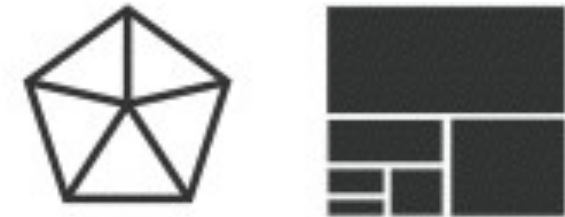
classified according to number of spatial dimensions
required



points (0D)



lines (1D)



areas (2D)



MARKS

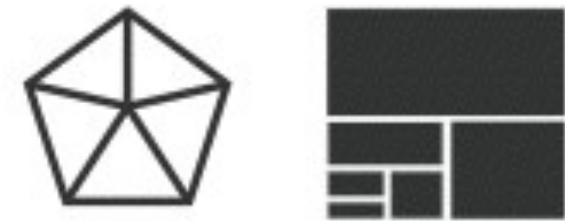
marks as nodes (items)



points (0D)



lines (1D)



areas (2D)

marks as links



containment



connection



CHANNELS

parameters that control the appearance of marks

➔ Position

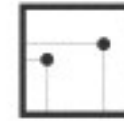
➔ Horizontal



➔ Vertical



➔ Both



➔ Color



➔ Shape



➔ Tilt



➔ Size

➔ Length



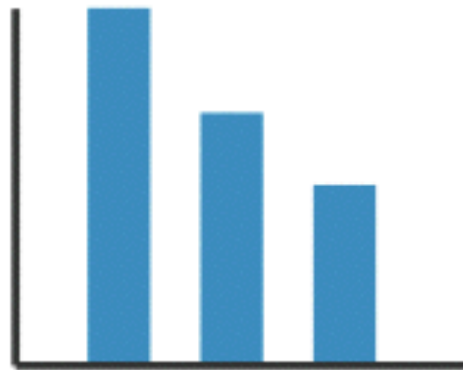
➔ Area



➔ Volume



NAME THAT MARK AND CHANNEL



CHANNEL TYPES

identity (what or where)

magnitude (how much)

➔ Position

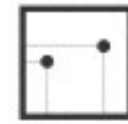
➔ Horizontal



➔ Vertical



➔ Both



➔ Color



➔ Shape



➔ Tilt



➔ Size

➔ Length



➔ Area




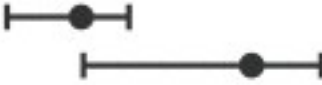








➔ Volume



EXPRESSIVENESS & EFFECTIVENESS



➔ **Magnitude Channels: Ordered Attributes**

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)	

(how much)

➔ **Identity Channels: Categorical Attributes**

Spatial region	
Color hue	
Motion	
Shape	

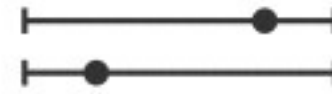
(what or where)

EXPRESSIVENESS

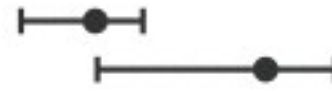


➔ **Magnitude Channels: Ordered Attributes**

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

Most
Effectiveness
Least

➔ **Identity Channels: Categorical Attributes**

Spatial region



Color hue



Motion



Shape



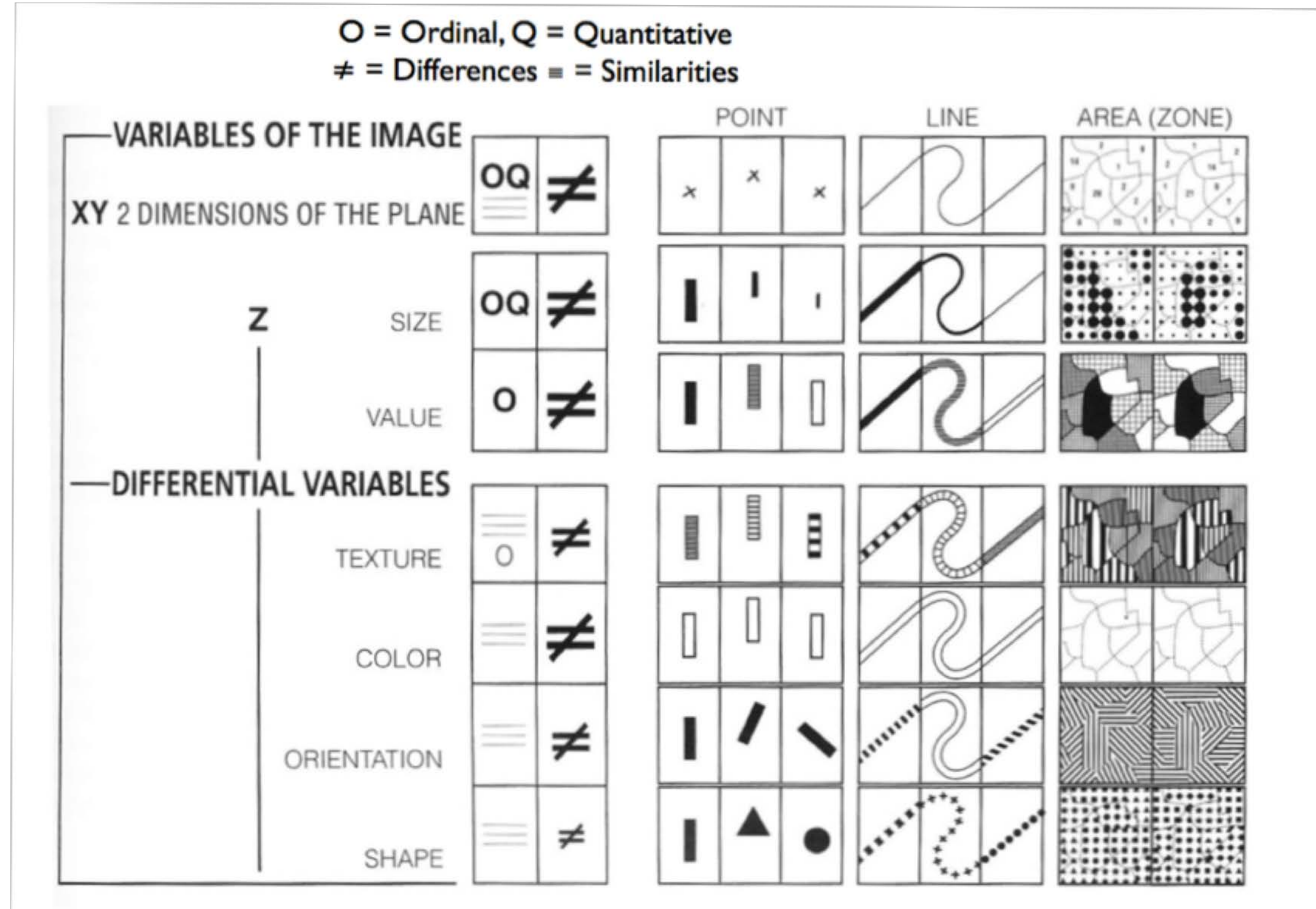
EFFECTIVENESS



WHERE DO RANKINGS COME FROM?



BERTIN, “SEMIOLOGY OF GRAPHICS”, 1967



CLEVELAND & MCGILL, “GRAPHICAL PERCEPTION AND GRAPHICAL METHODS FOR ANALYZING SCIENTIFIC DATA”, 1985

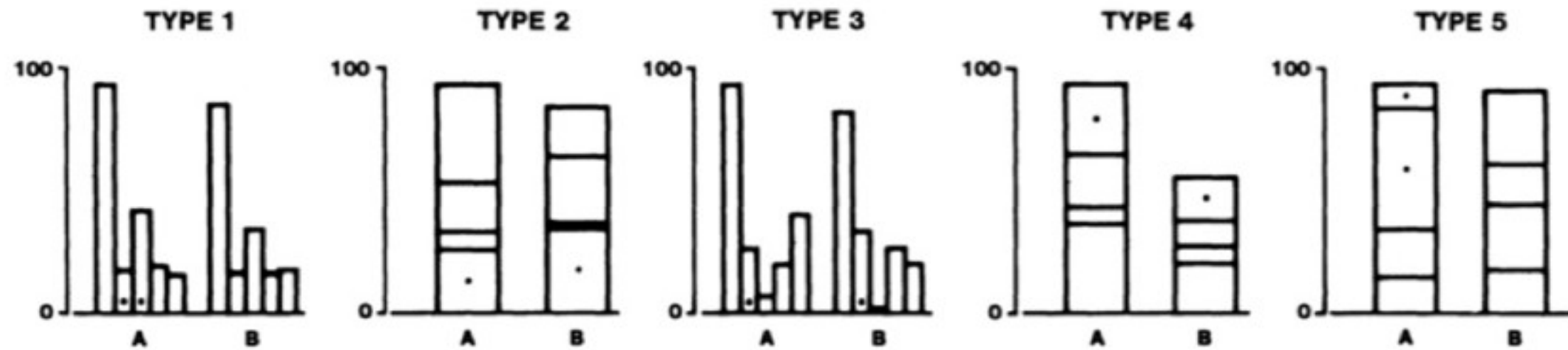


Figure 4. Graphs from position-length experiment.

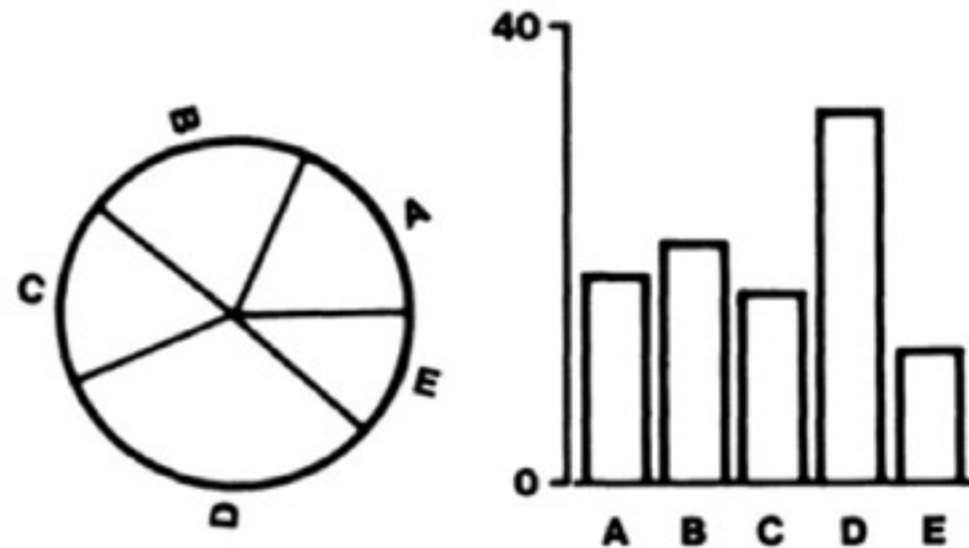


Figure 3. Graphs from position-angle experiment.



MACKINLAY, “AUTOMATING THE DESIGN OF GRAPHICAL PRESENTATIONS OF RELATIONAL INFORMATION”, 1986

Quantitative

Position
Length
Angle
Slope
Area
Volume
Density
Saturation
Hue
Texture
Connection
Containment
Shape



Ordinal

Position
Density
Saturation
Hue
Texture
Connection
Containment
Length
Angle
Slope
Area
Volume
Shape



Nominal

Position
Hue
Texture
Connection
Containment
Density
Saturation
Shape
Length
Angle
Slope
Area
Volume



HEER & BOSTOCK, “CROWDSOURCING GRAPHICAL PERCEPTION: USING MECHANICAL TURK TO ASSESS VISUALIZATION DESIGN”, 2010

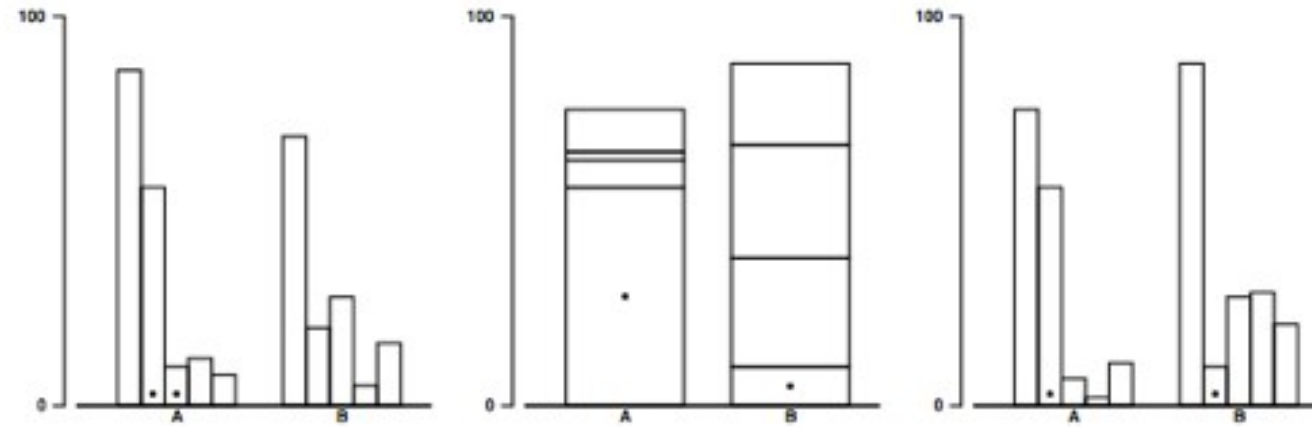


Figure 1: Stimuli for judgment tasks T1, T2 & T3. Subjects estimated percent differences between elements.

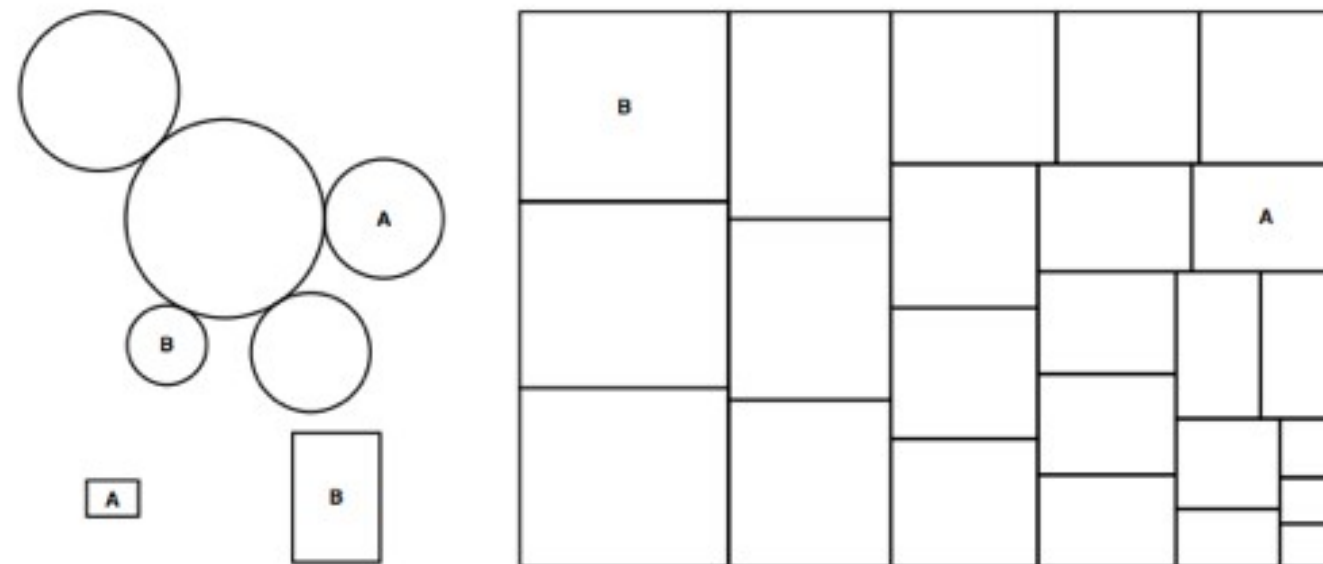
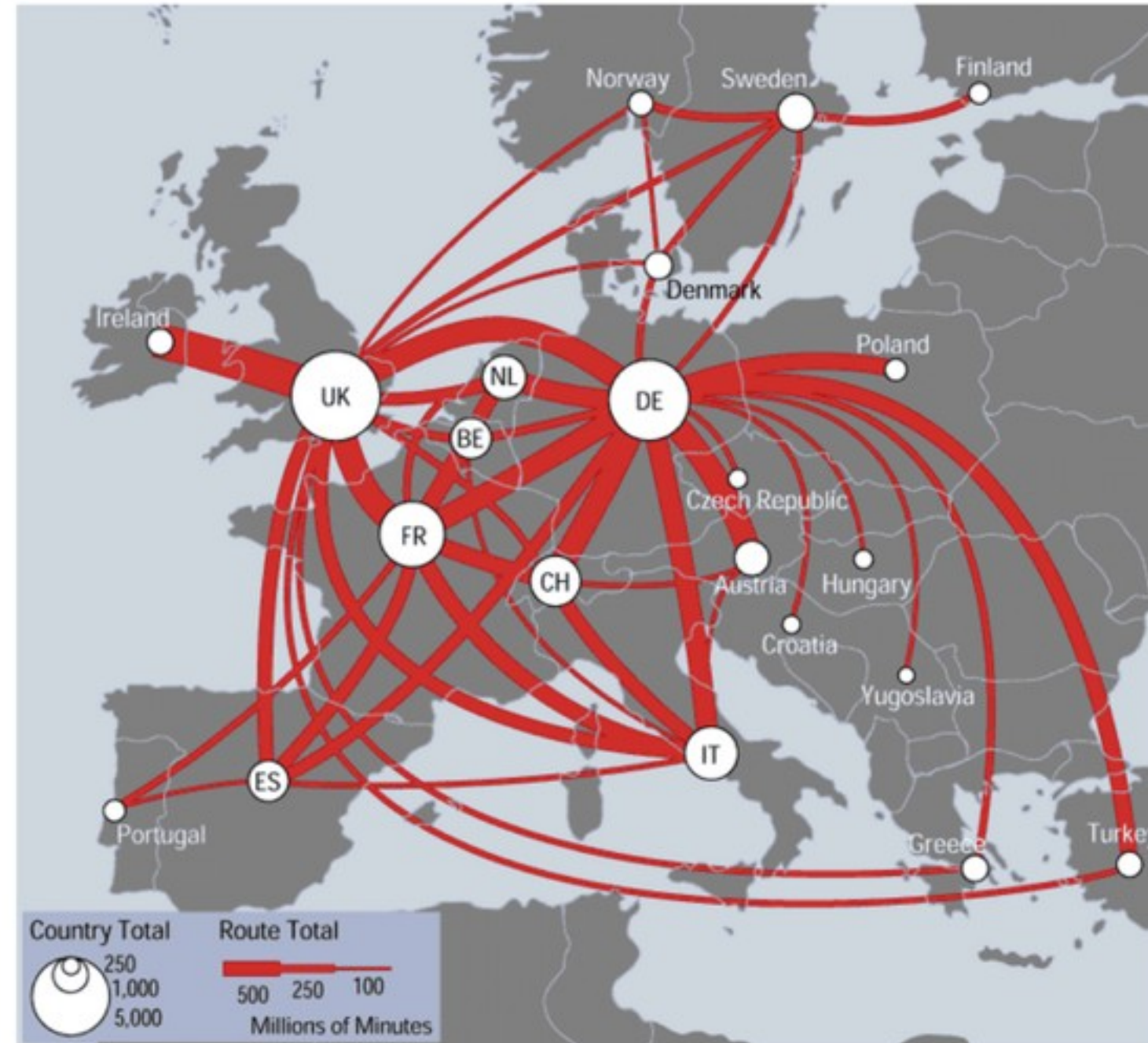


Figure 2: Area judgment stimuli. Top left: Bubble chart (T7), Bottom left: Center-aligned rectangles (T8), Right: Treemap (T9).



DISCRIMINABILITY

can channel differences be discerned?

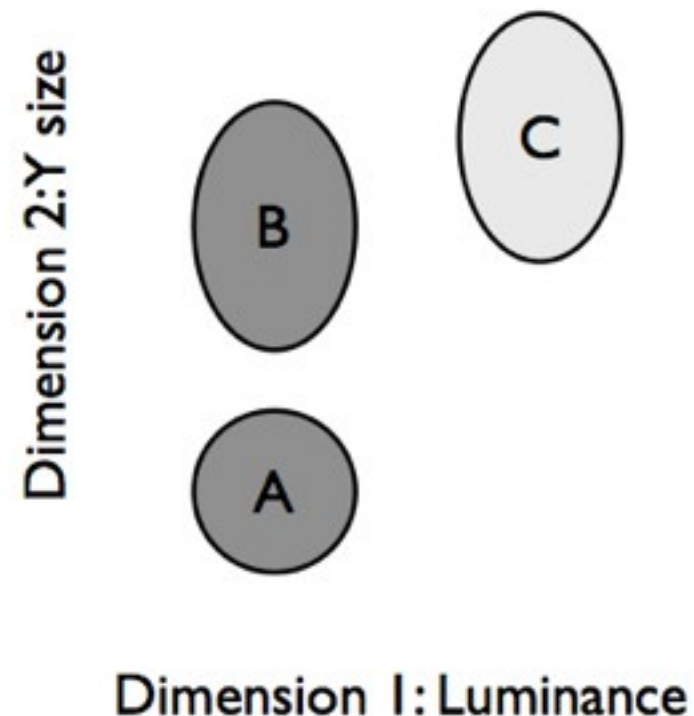


SEPARABLE vs INTEGRAL

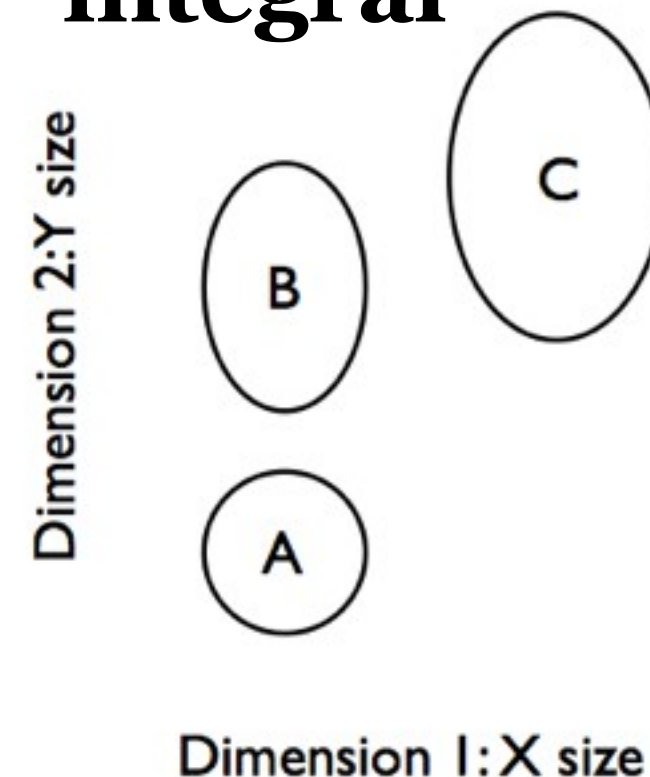
separable: can judge each channel individually

integral: two channels are viewed holistically

separable



integral



SEPARABLE vs INTEGRAL

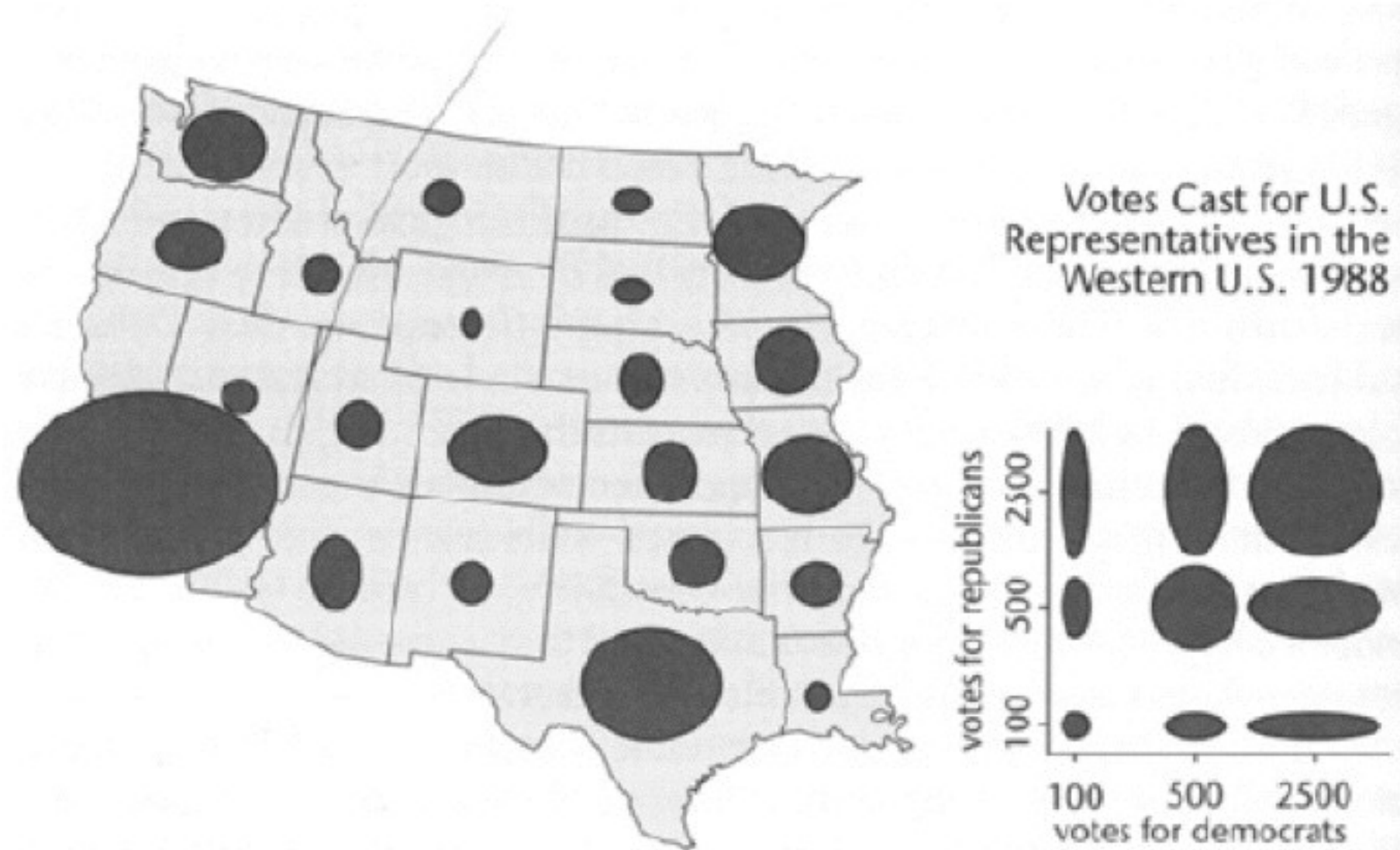


FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

SEPARABLE vs INTEGRAL

separable ← → integral



color | location

color | motion

color | shape

size | orientation

x-size | y-size

red-green | yellow-blue



READING, WRITING, AND EARNING MONEY

The latest data from the U.S. Census's American Community Survey paints a fascinating picture of the United States at the county level. We've looked at the educational achievement and the median income of the entire nation, to see where people are going to school, where they're earning money, and if there is any correlation.



A HIGH SCHOOL GRADUATES 60% 70% 80% 90%



B COLLEGE GRADUATES 20% 25% 30% 40%

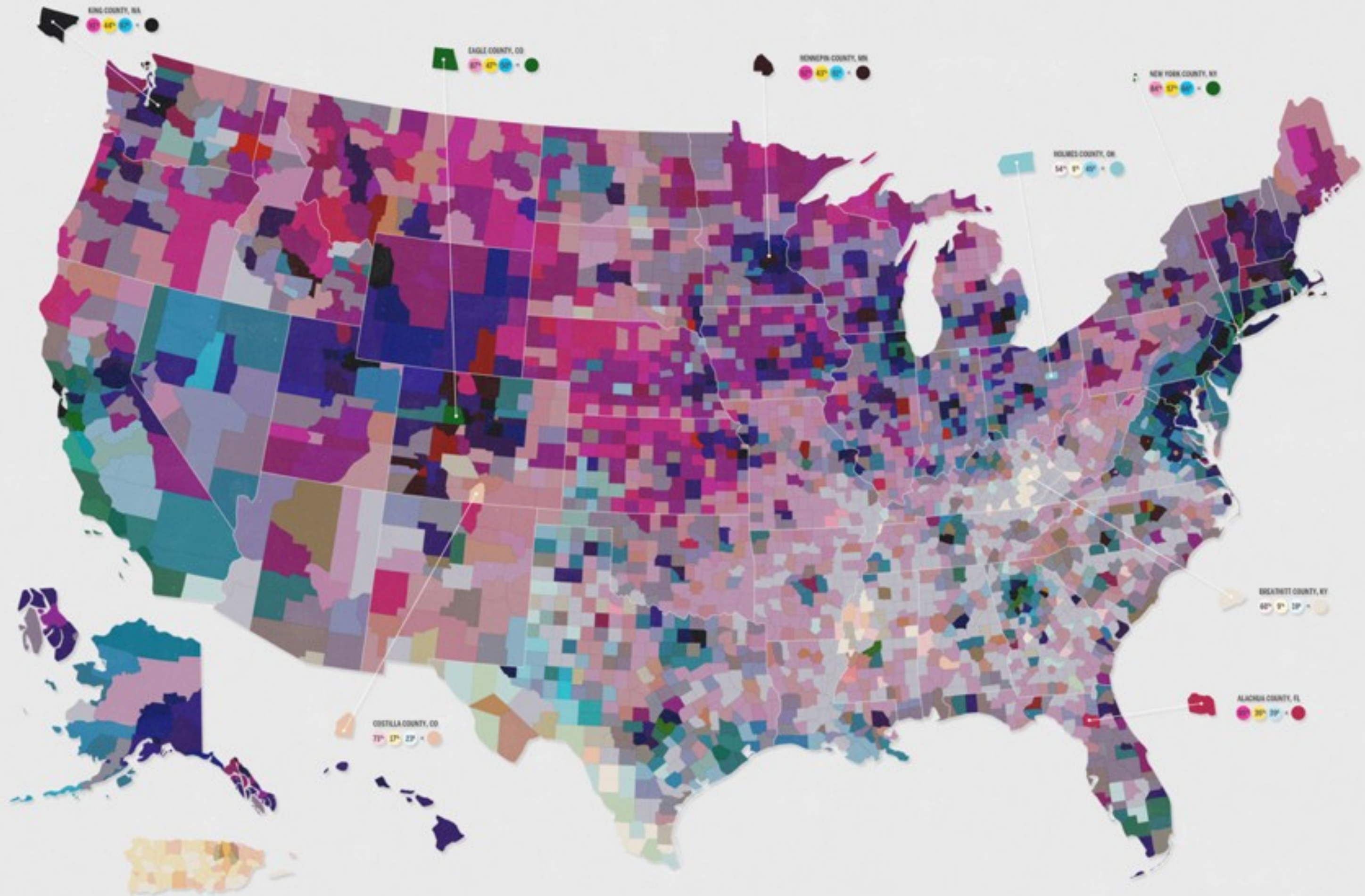


C MEDIAN HOUSEHOLD INCOME 20K 40K 60K 80K

The map at right is a product of overlaying the three sets of data. The variation in hue and value has been produced from the data shown above. In general, darker counties represent a more educated, better paid population while lighter areas represent communities with fewer graduates and lower incomes.

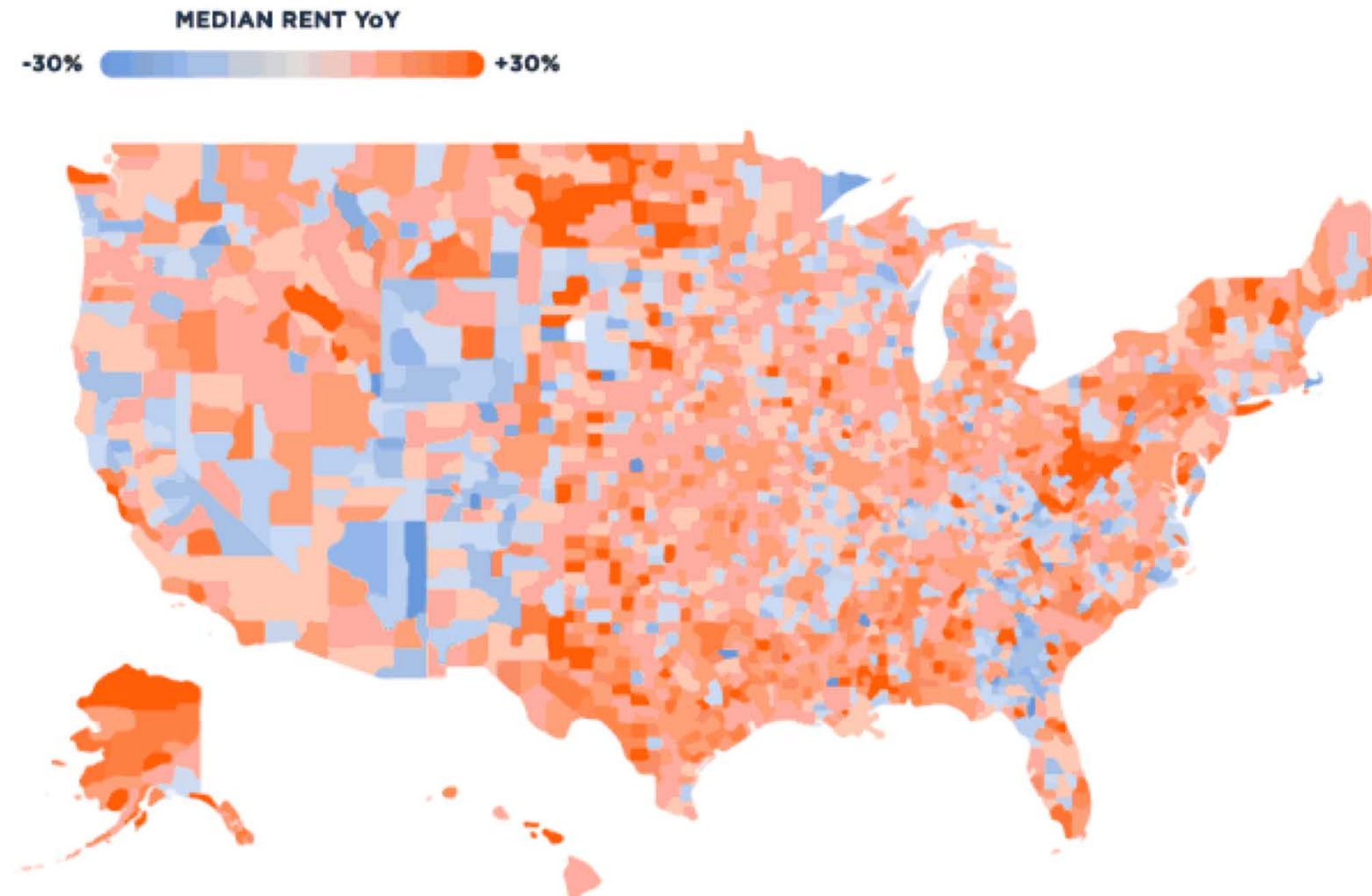


A collaboration between GOOD and Gregory Mularik
SOURCE: US Census





**Rents are rising in 78% of counties in the U.S.,
year-over-year, increasing the urge to buy.⁴**



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



+ PERCEPTUAL EFFECTS WE WILL
DISCUSS NEXT LECTURE

pop-out

steven's power law

weber's law

gestalt principles




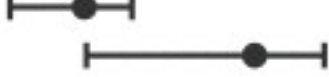
PLANAR POSITION

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 

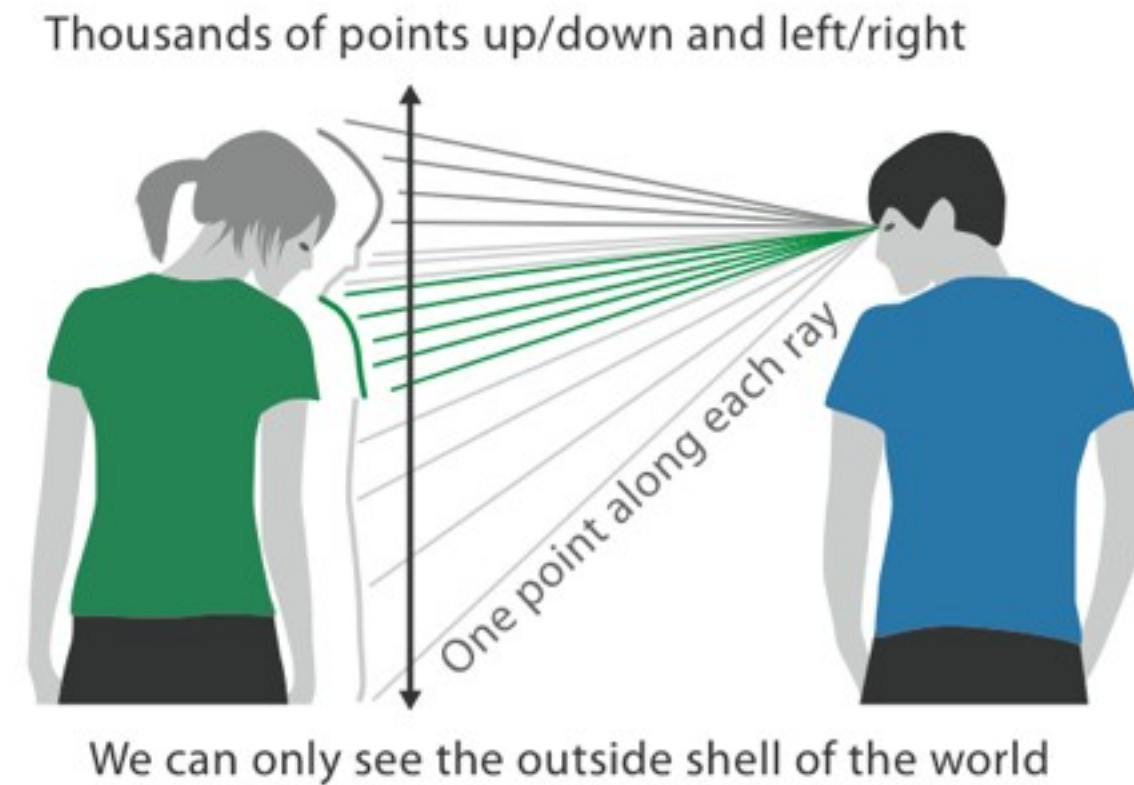
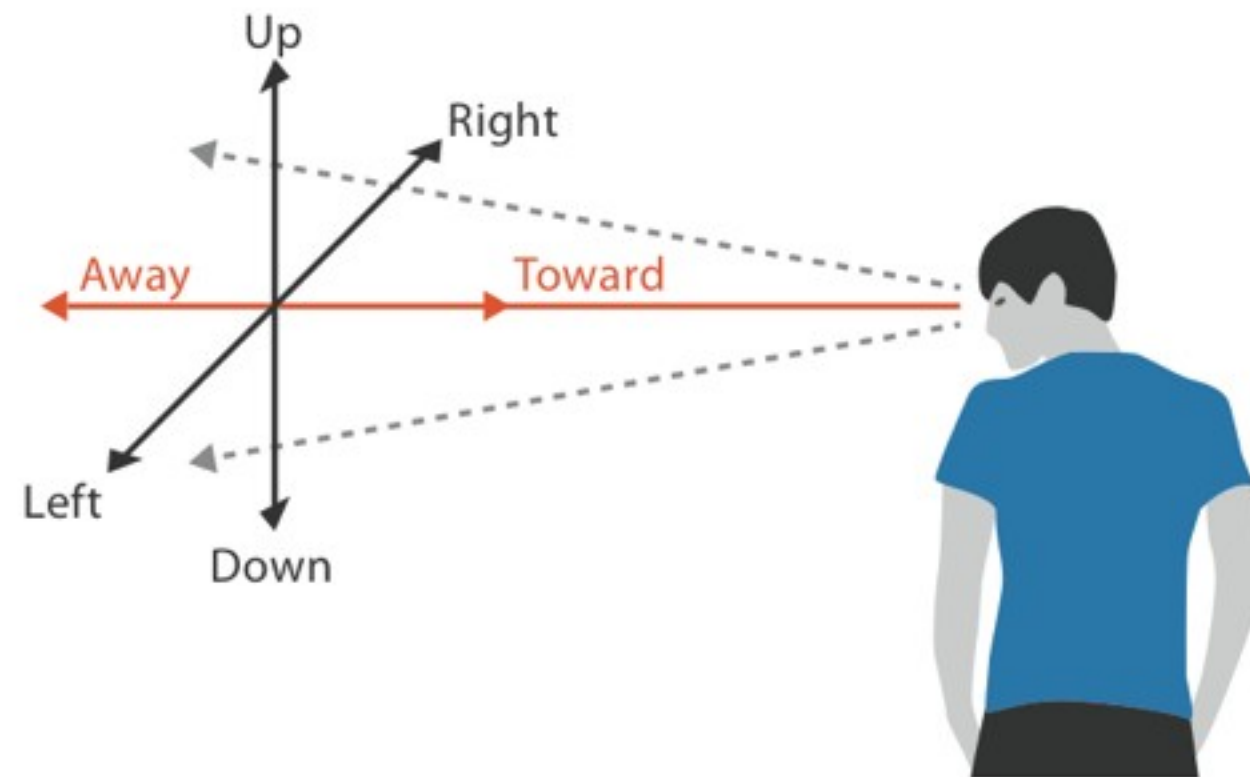
Color hue 

Motion 

Shape 



~~2.5D~~ 2.05D



POWER DOES NOT EXTEND TO 3D

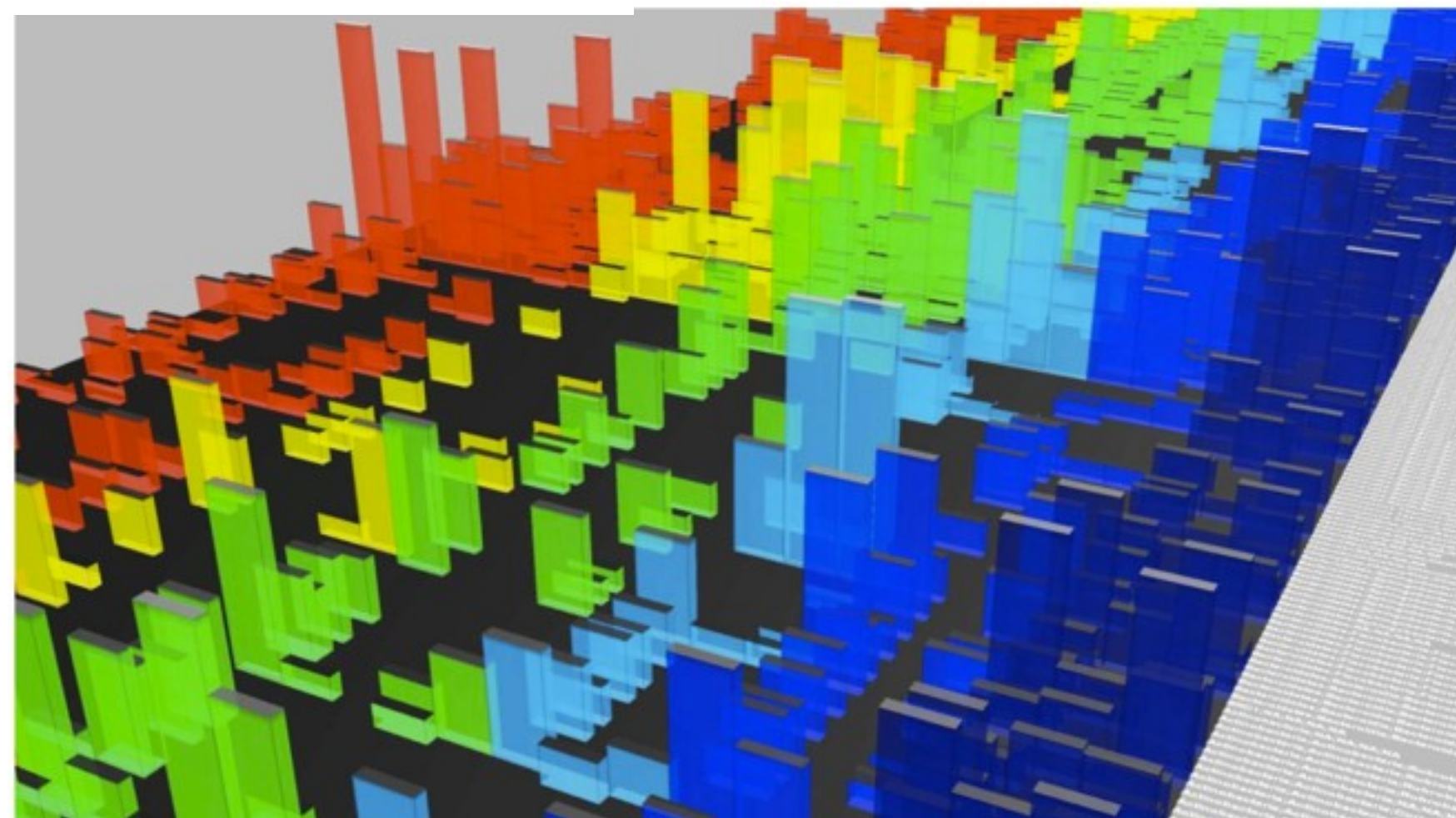
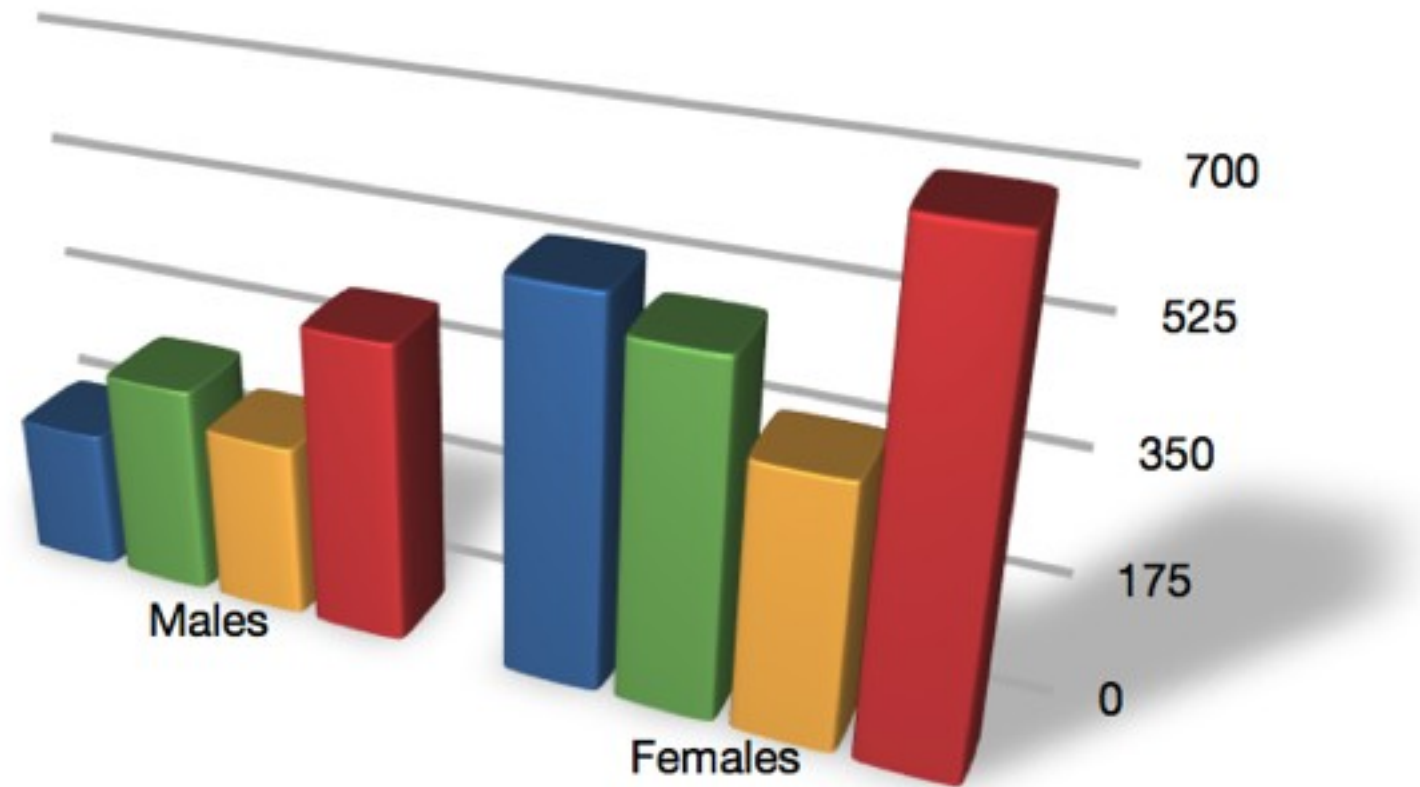
perspective cues

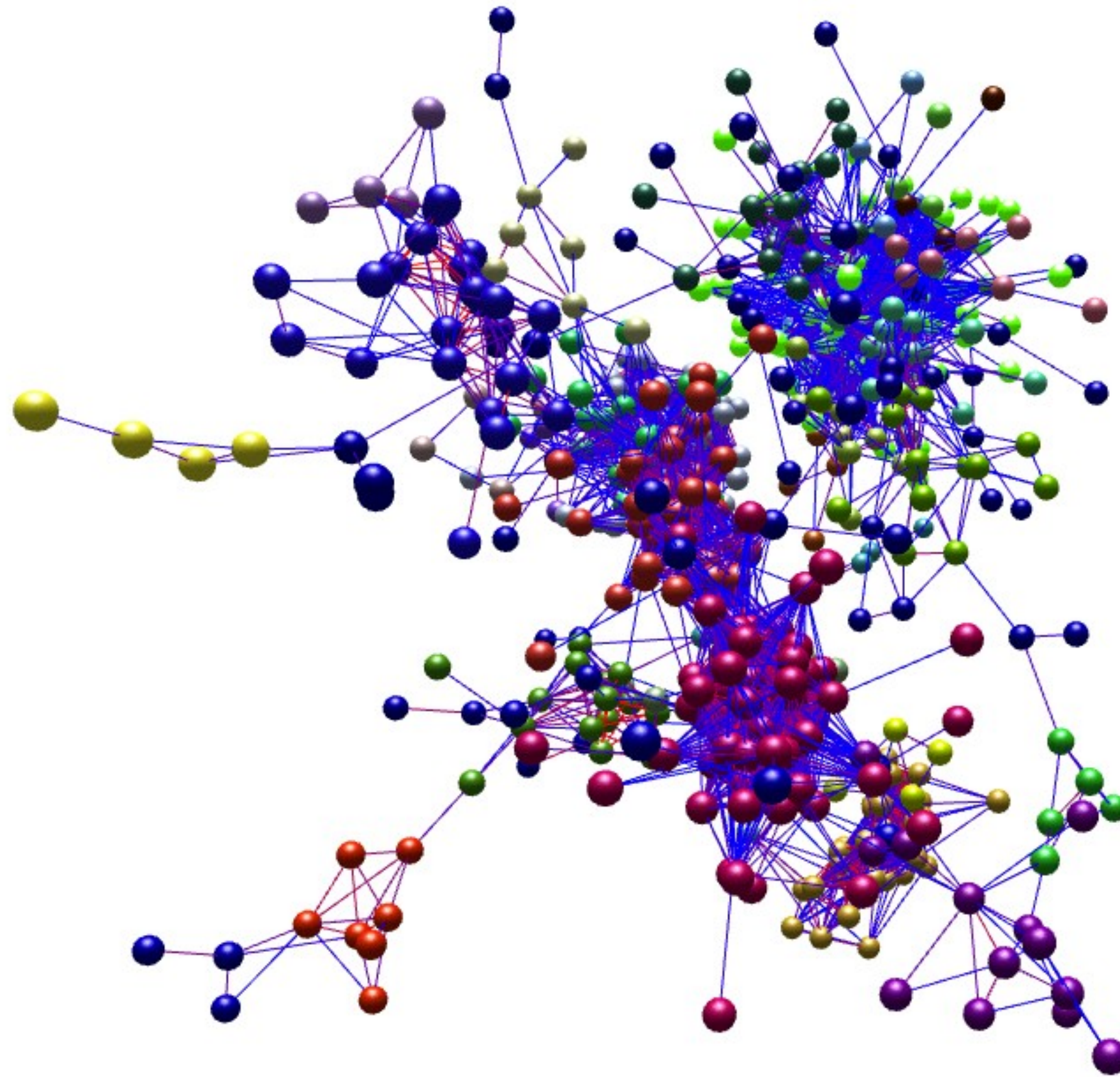
interfere with color and size channels

occlusion of data

text legibility







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?



www.comparotpuzzles.com © 2001 Bonnie J. Malcolm



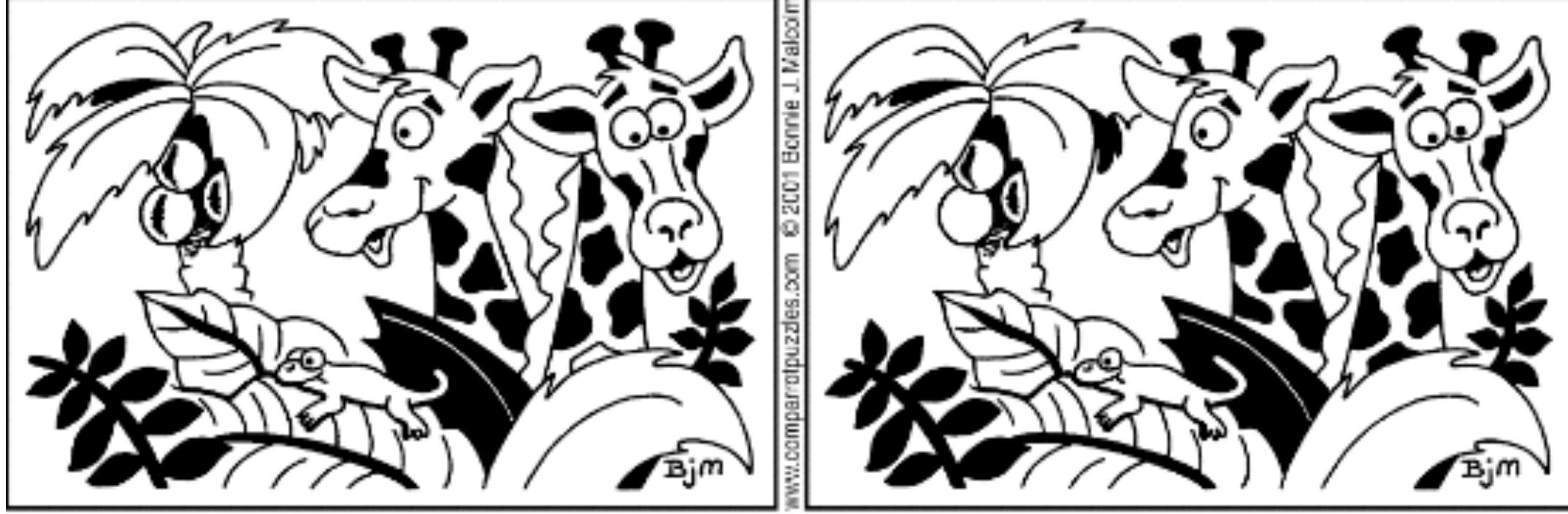
ComParrot
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



ComParrot
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?



www.comparotpuzzles.com © 2001 Bonnie J. Malcolm

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

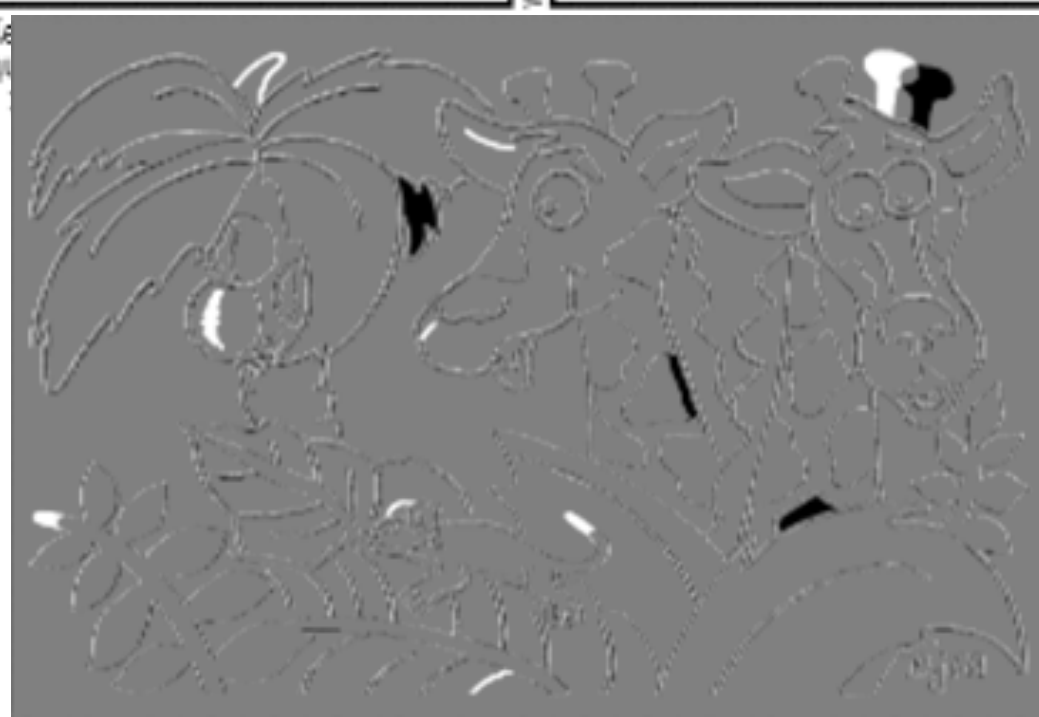
Can you spot 12 differences between these pictures?



www.comparotpuzzles.com © 2001 Bonnie J. Malcolm



removed. 4. Leaf vein below gecko
 of tree colored in. 5. Horn on right
 eye missing.



Solution: 1. Top tree leaf removed. 2.
 removed. 3. Ear line on left giraffe re-
 giraffe moved. 4. Spot on left giraffe m-



WHEN TO USE ANIMATION?



GOOD: STORYTELLING

Hans Rosling shows the best stats you've ever seen | Video on TED.com

http://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html

Sign In | Register

TED Ideas worth spreading

Talks
Speakers
Themes
Translations

TED Conferences
TEDx Events
TED Prize
TED Fellows


TED Conversations **NEW**
TED Community
TED Blog
TED Initiatives

Search

TALKS

Hans Rosling shows the best stats you've ever seen

TED2006, Filmed Feb 2006; Posted Jun 2006



3,471,109 Views

Like 33k

INTERACTIVE TRANSCRIPT

ABOUT THE SPEAKER

ABOUT THIS TALK

You've never seen data presented like this. With the drama and urgency of a sportscaster, statistics guru Hans Rosling debunks myths about the so-called "developing world."

THE ROLEX ARTS INITIATIVE PAIRS ESTABLISHED MENTORS WITH EMERGING PROTÉGÉS FOR A YEAR OF CREATIVE COLLABORATION

WHAT TO WATCH NEXT

00:17 | 19:53

Share Rate



GOOD: TRANSITIONS

Hans Rosling shows the best stats you've ever seen | Video on TED.com

http://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen.html

Sign In | Register

TED Ideas worth spreading

Talks
Speakers
Themes
Translations

TED Conferences
TEDx Events
TED Prize
TED Fellows


TED Conversations **NEW**
TED Community
TED Blog
TED Initiatives

Search

TALKS

Hans Rosling shows the best stats you've ever seen

TED2006, Filmed Feb 2006; Posted Jun 2006



3,471,109 Views ?

Like 33k

INTERACTIVE TRANSCRIPT

ABOUT THE SPEAKER

ABOUT THIS TALK

You've never seen data presented like this. With the drama and urgency of a sportscaster, statistics guru Hans Rosling debunks myths about the so-called "developing world."

THE ROLEX ARTS INITIATIVE PAIRS ESTABLISHED MENTORS WITH EMERGING PROTÉGÉS FOR A YEAR OF CREATIVE COLLABORATION

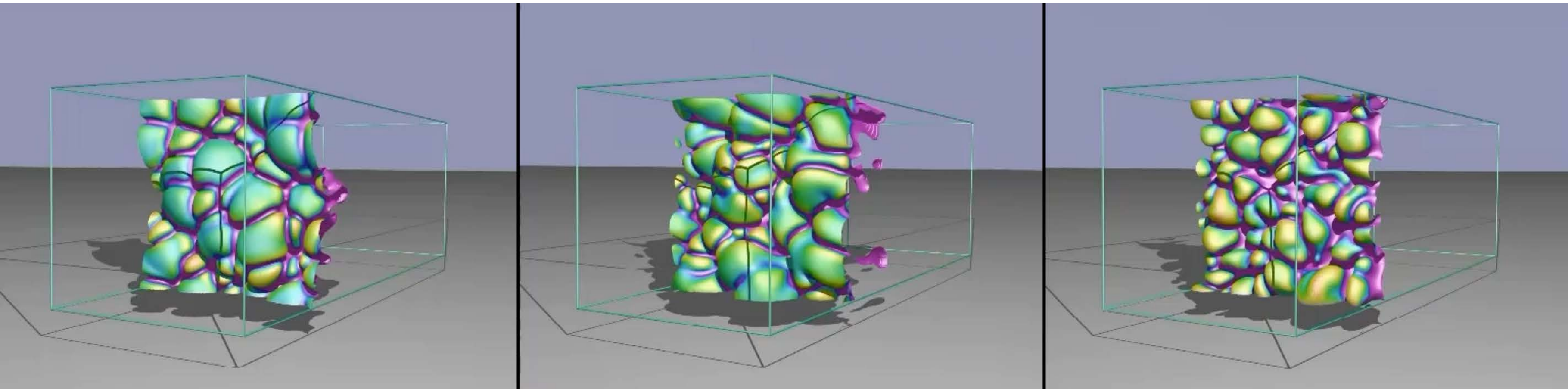
WHAT TO WATCH NEXT

00:17 | 19:53

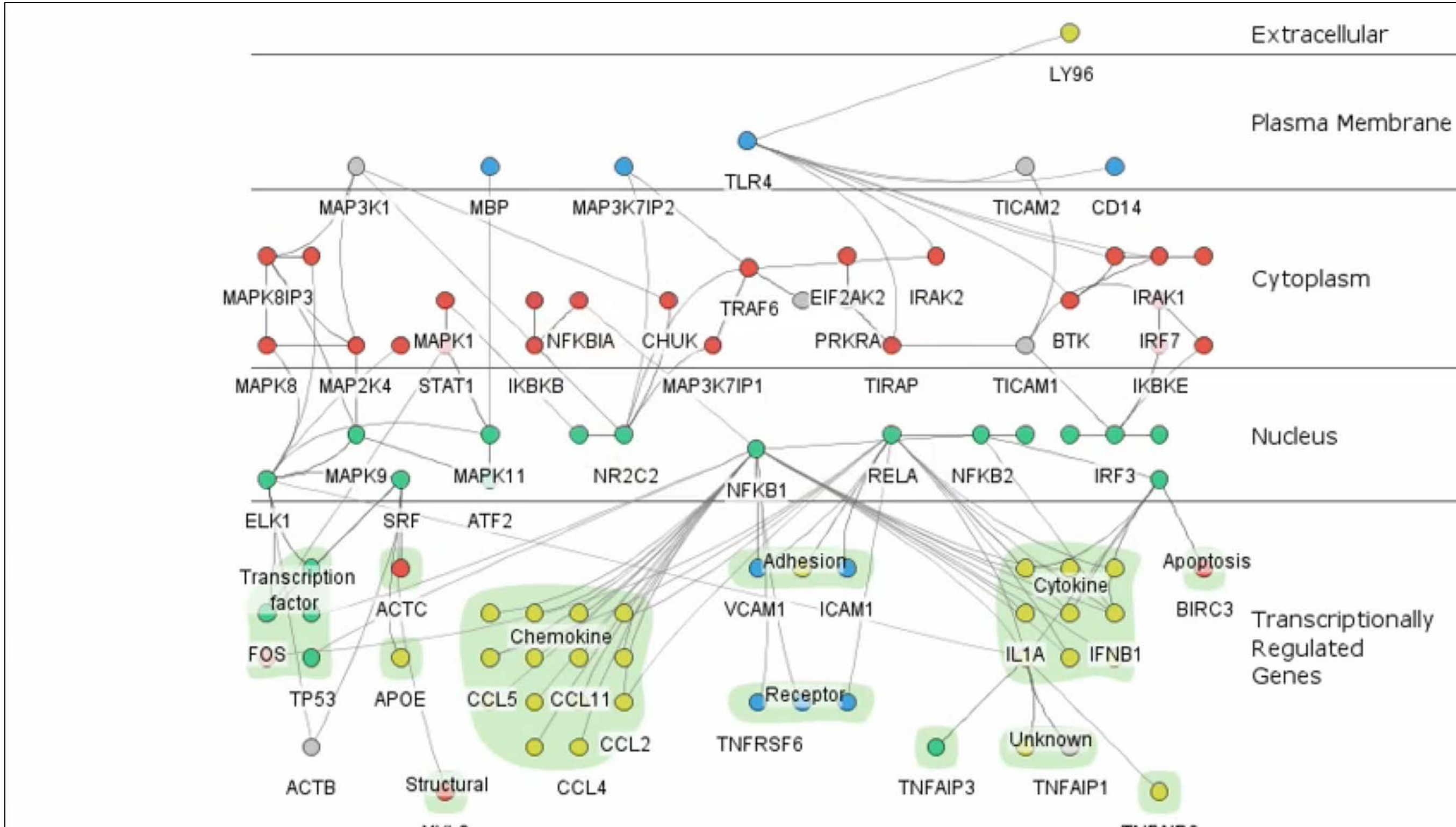
Share Rate



BAD: COMPARING COMPLEX STATE CHANGES OVER TIME

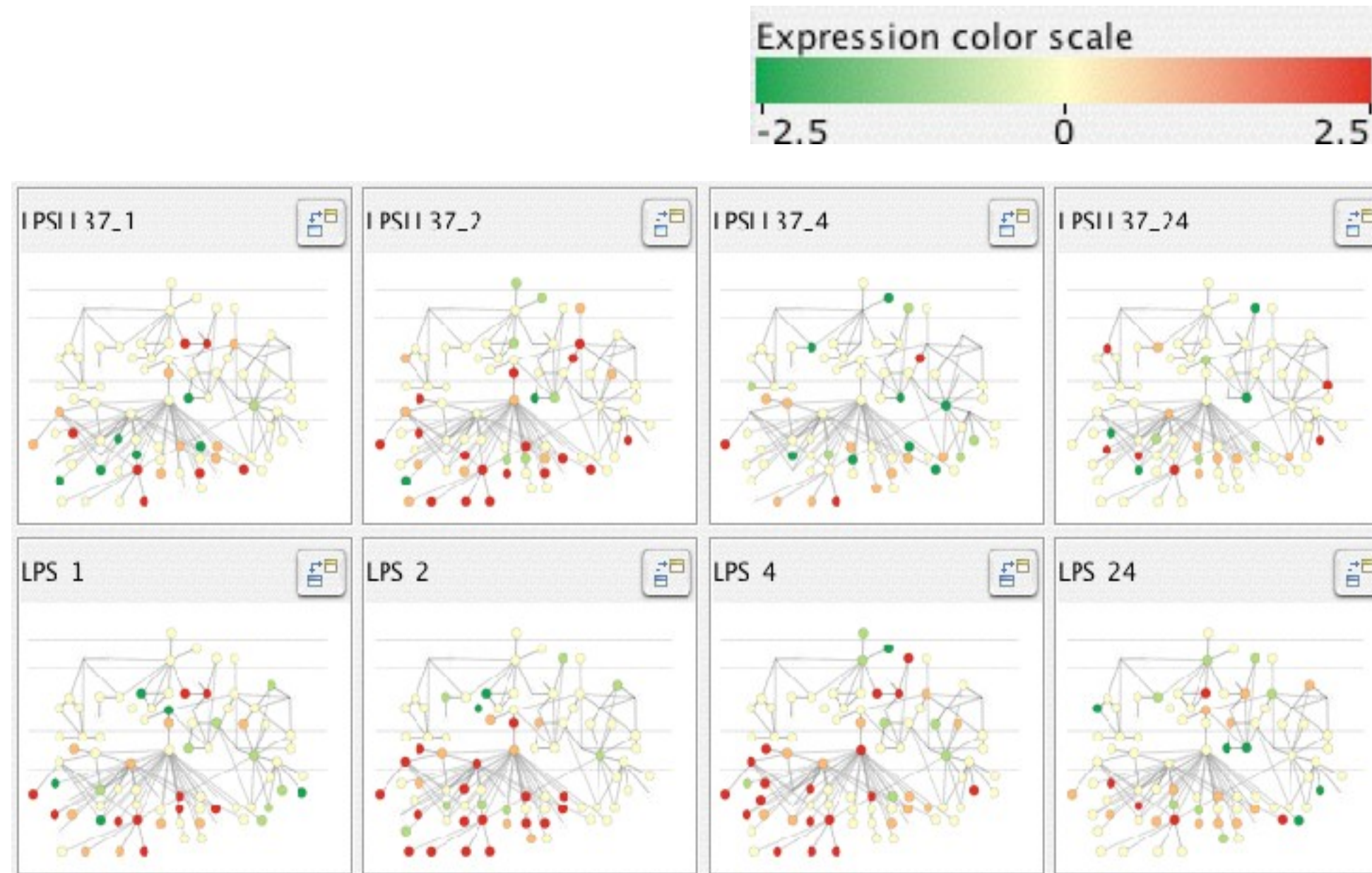


BAD: MULTIPLE STATES WITH MULTIPLE CHANGES



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)



