

Data Visualization Principles: Other Perceptual Channels

CSC444

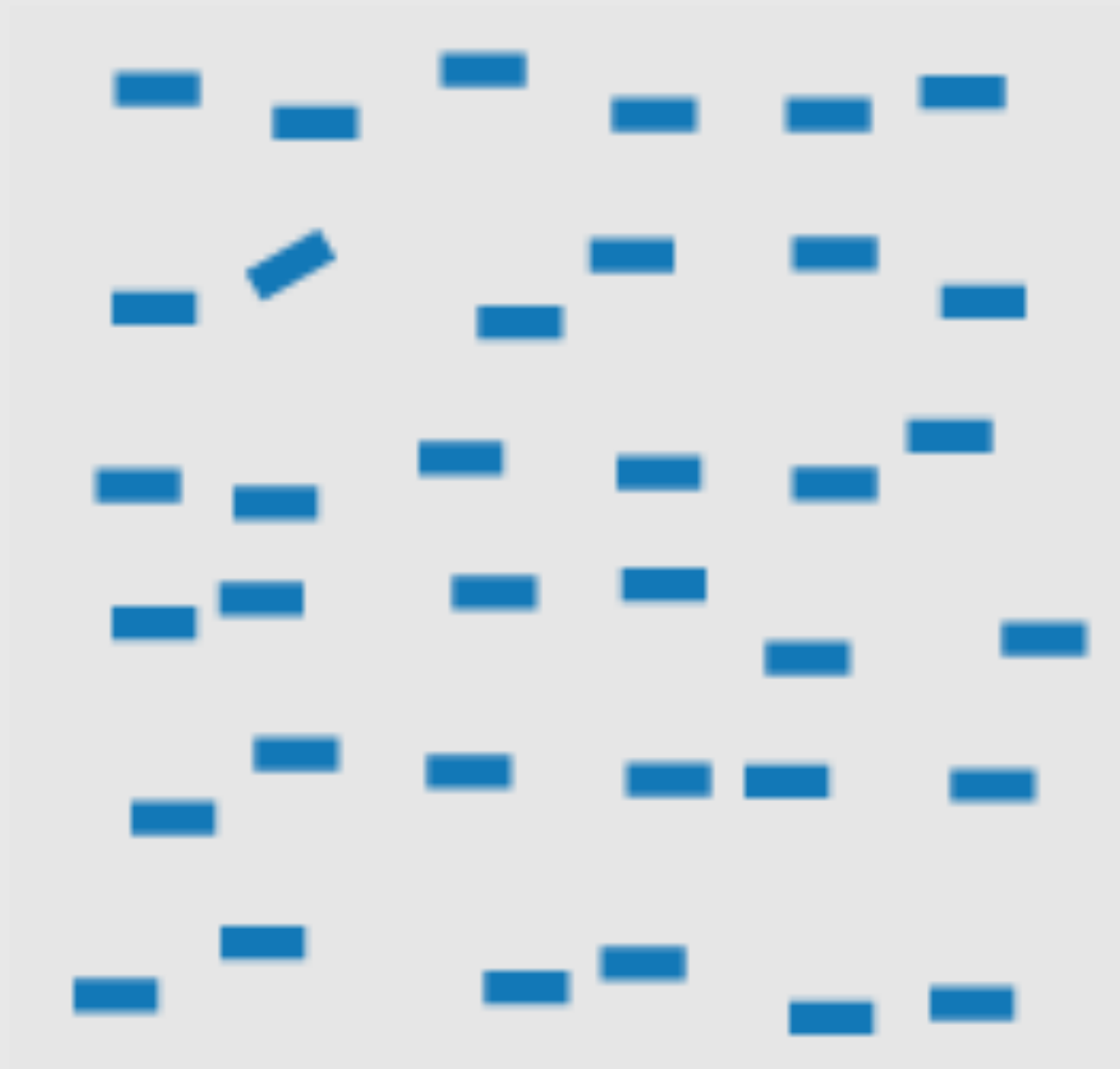
Acknowledgments for today's lecture:

Tamara Munzner, Miriah Meyer, Colin Ware, Christopher Healey

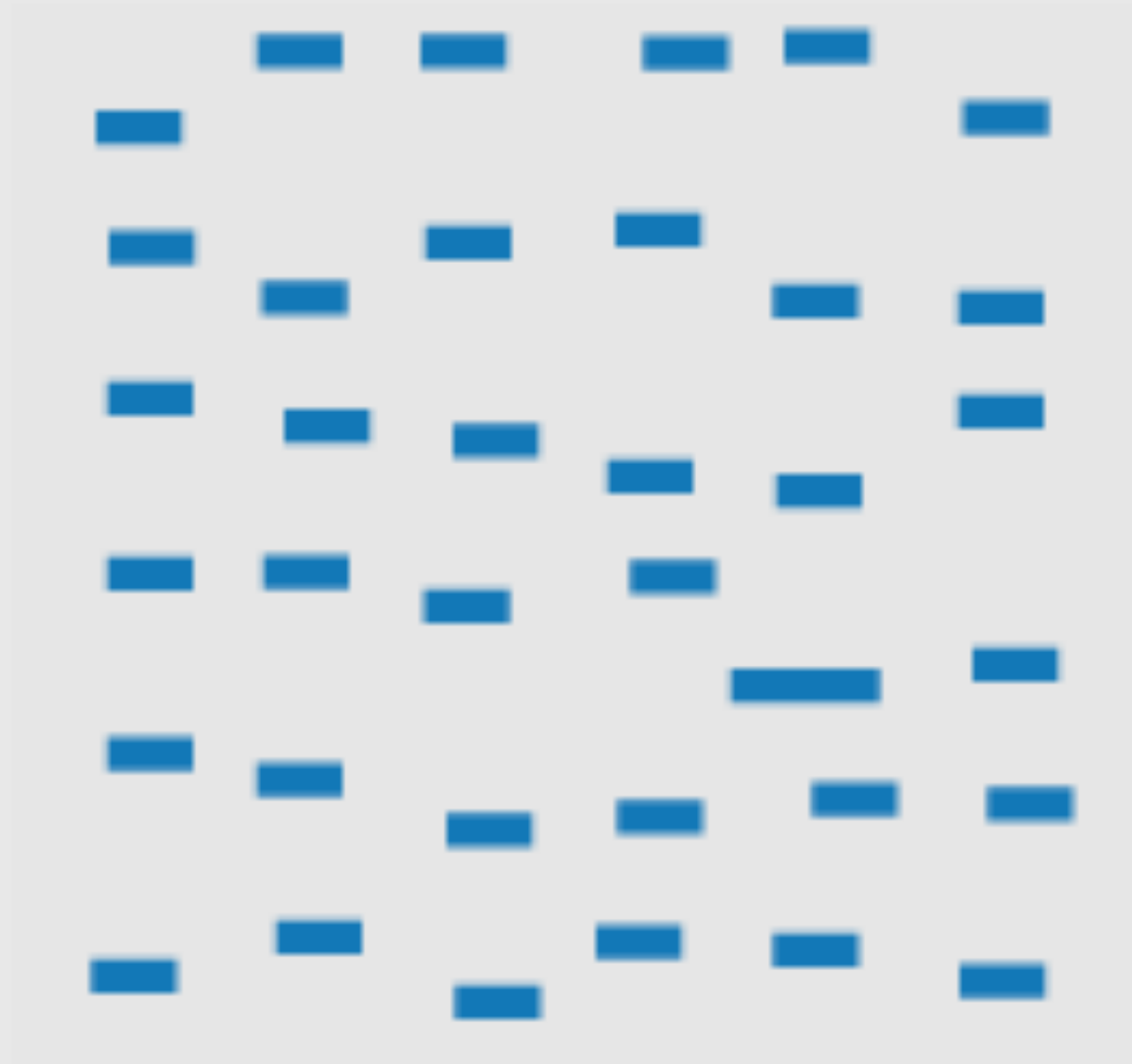
PREATTENTIVENESS,

OR “VISUAL POP-OUT”

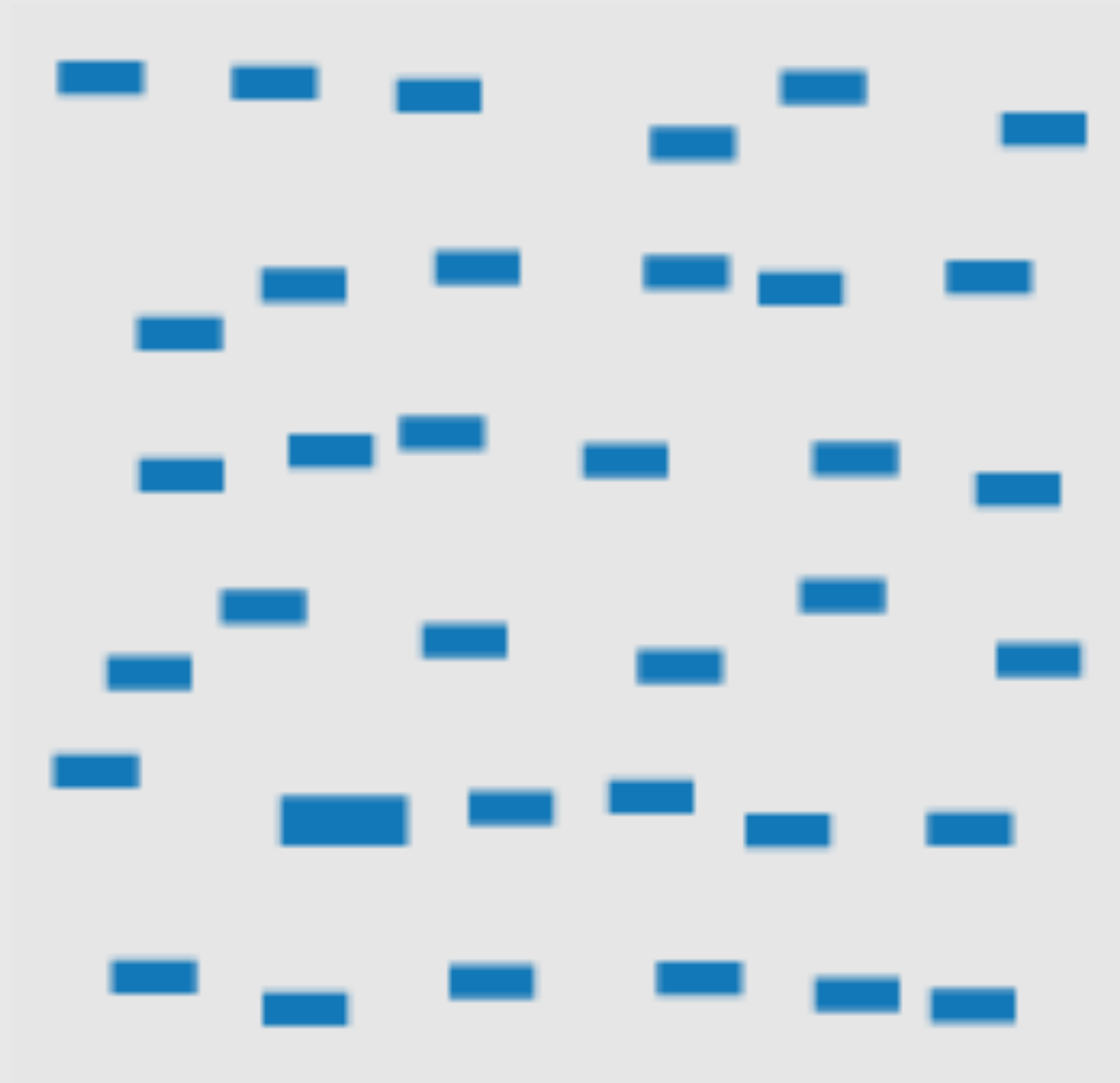
ORIENTATION

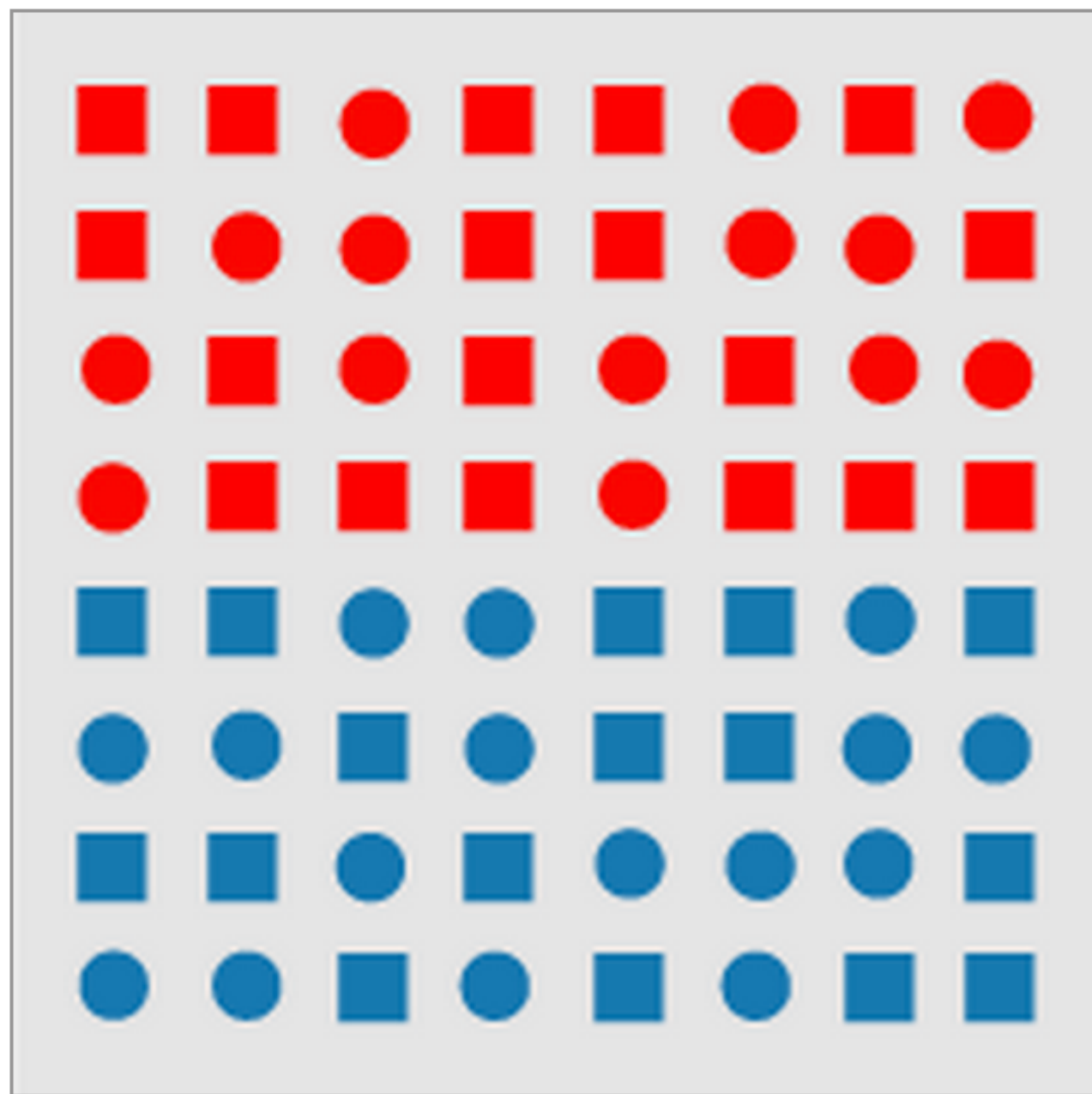


WIDTH/LENGTH

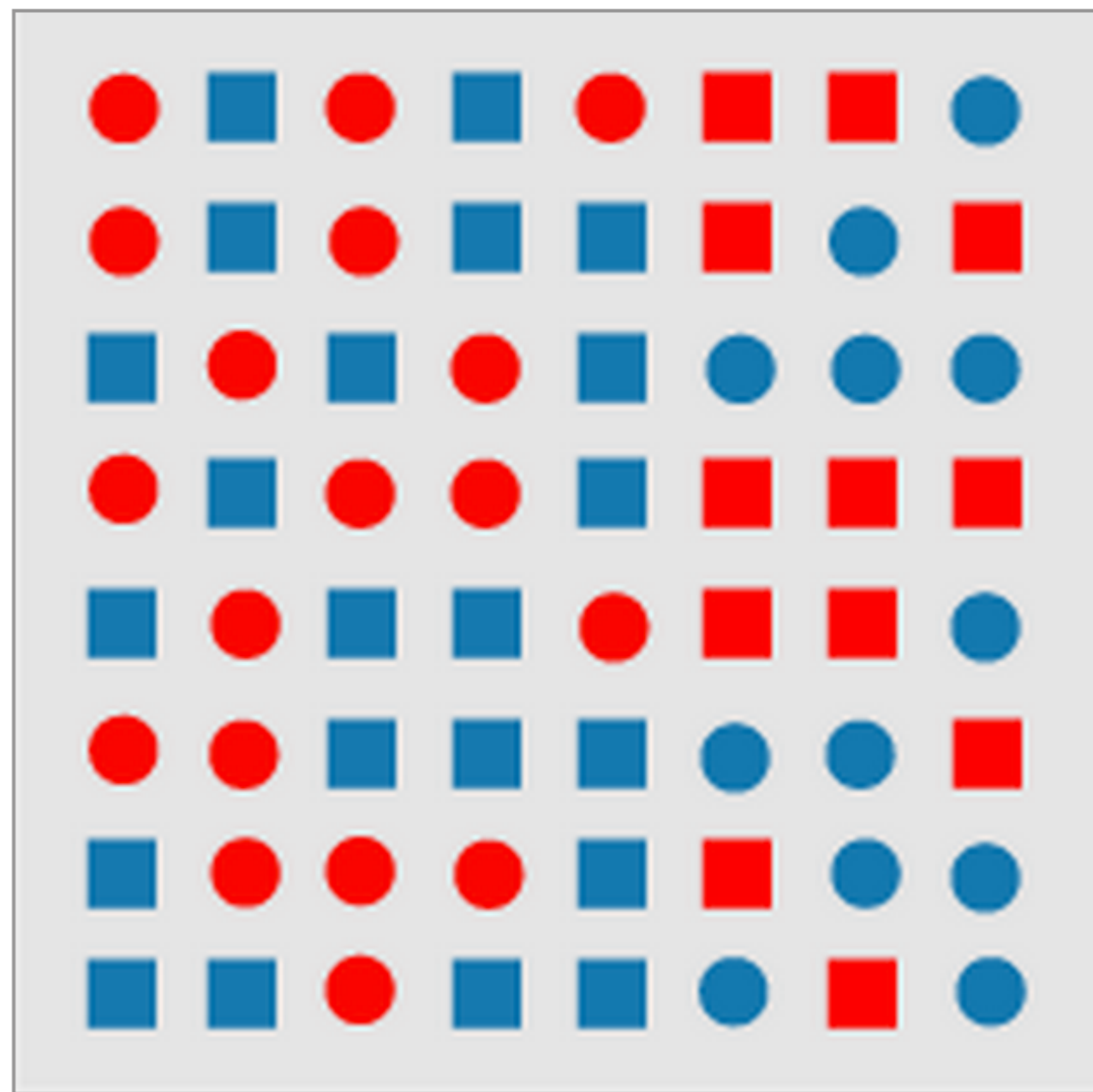


SIZE



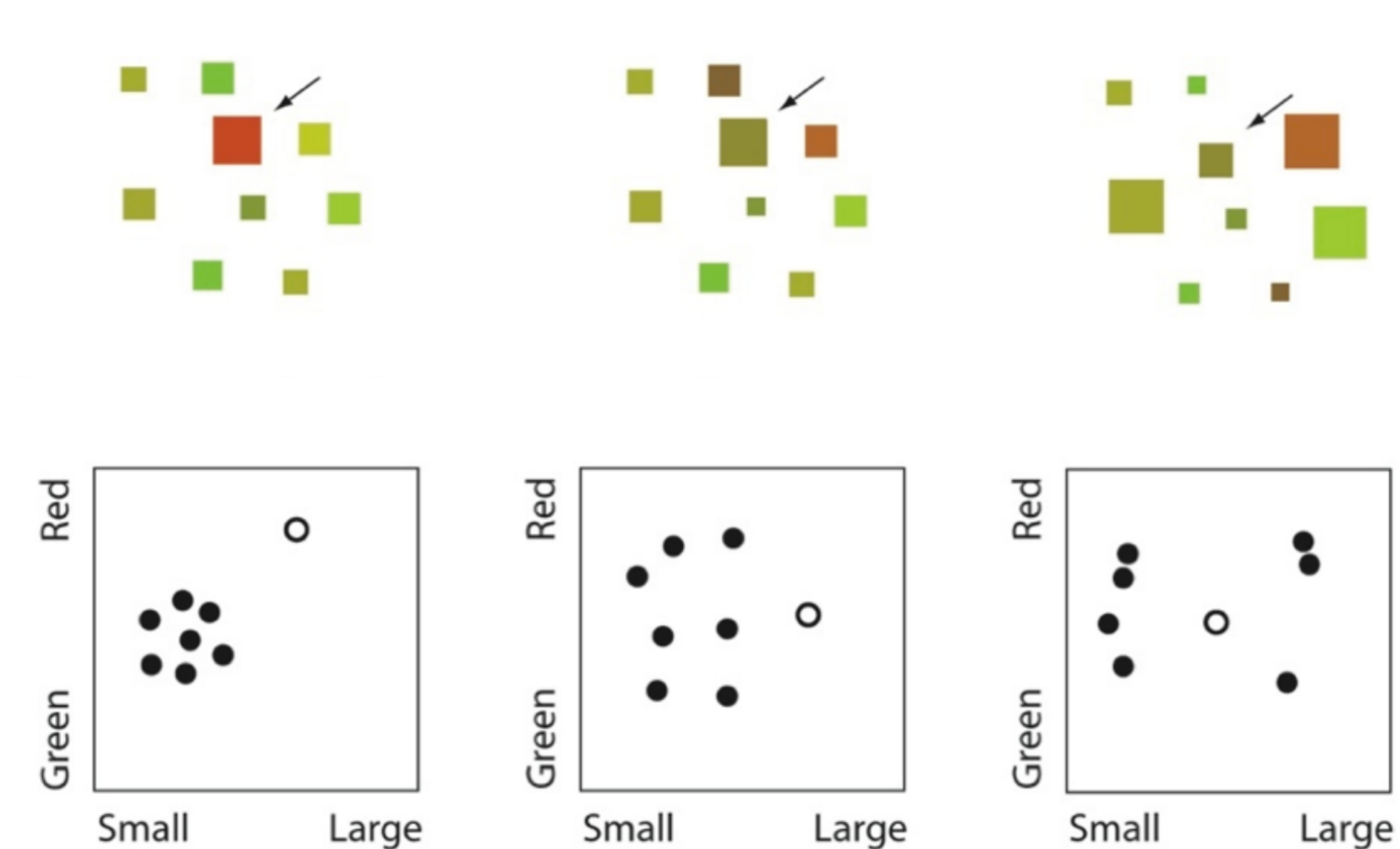


(a)



(b)

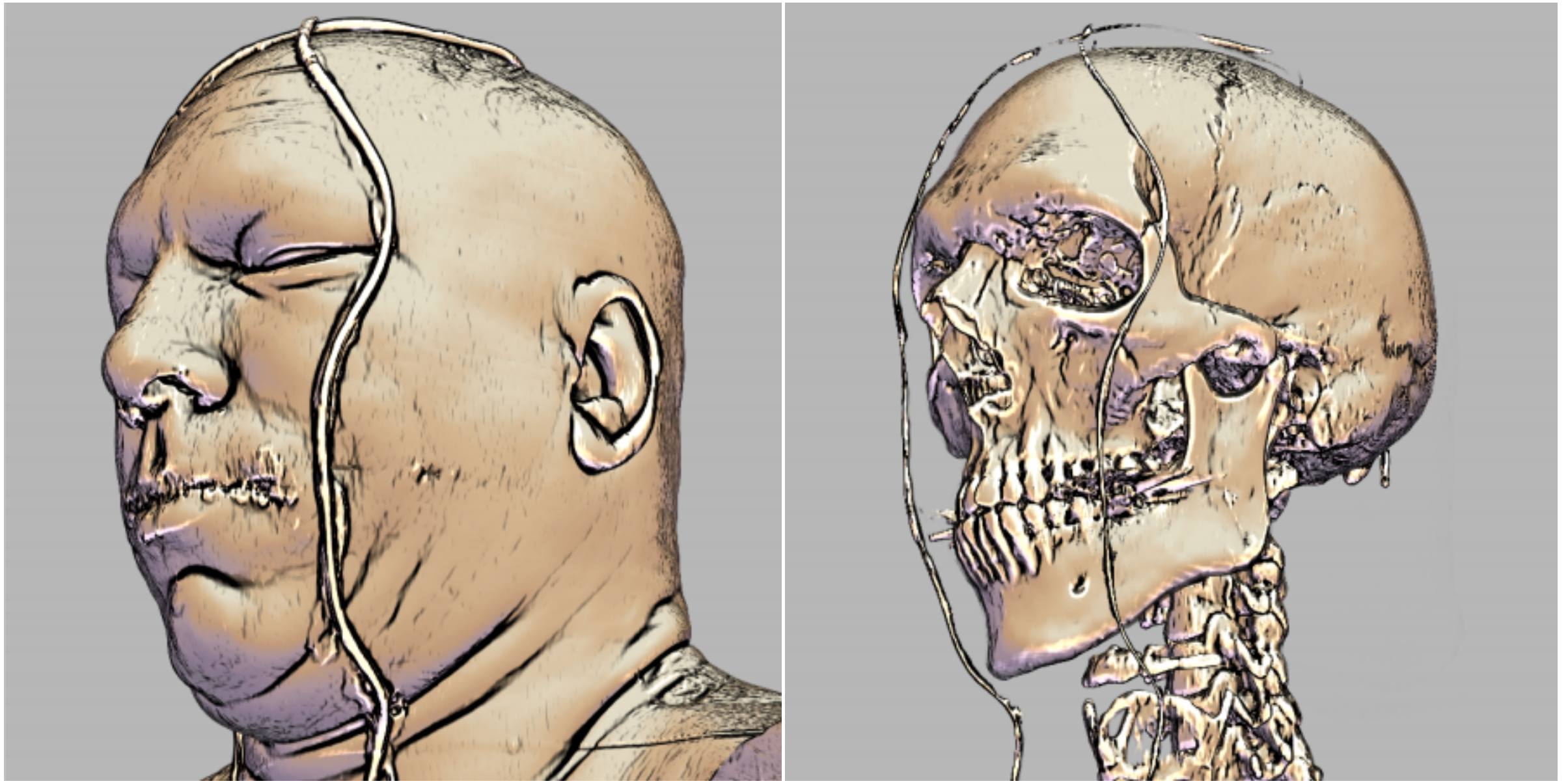
Mixing is not always pre-attentive



Preattentiveness is only
simple to understand
when considering one
channel at a time.

VISUAL CHANNELS
YOU SHOULD BE
CAREFUL WITH,
EVEN IN ISOLATION

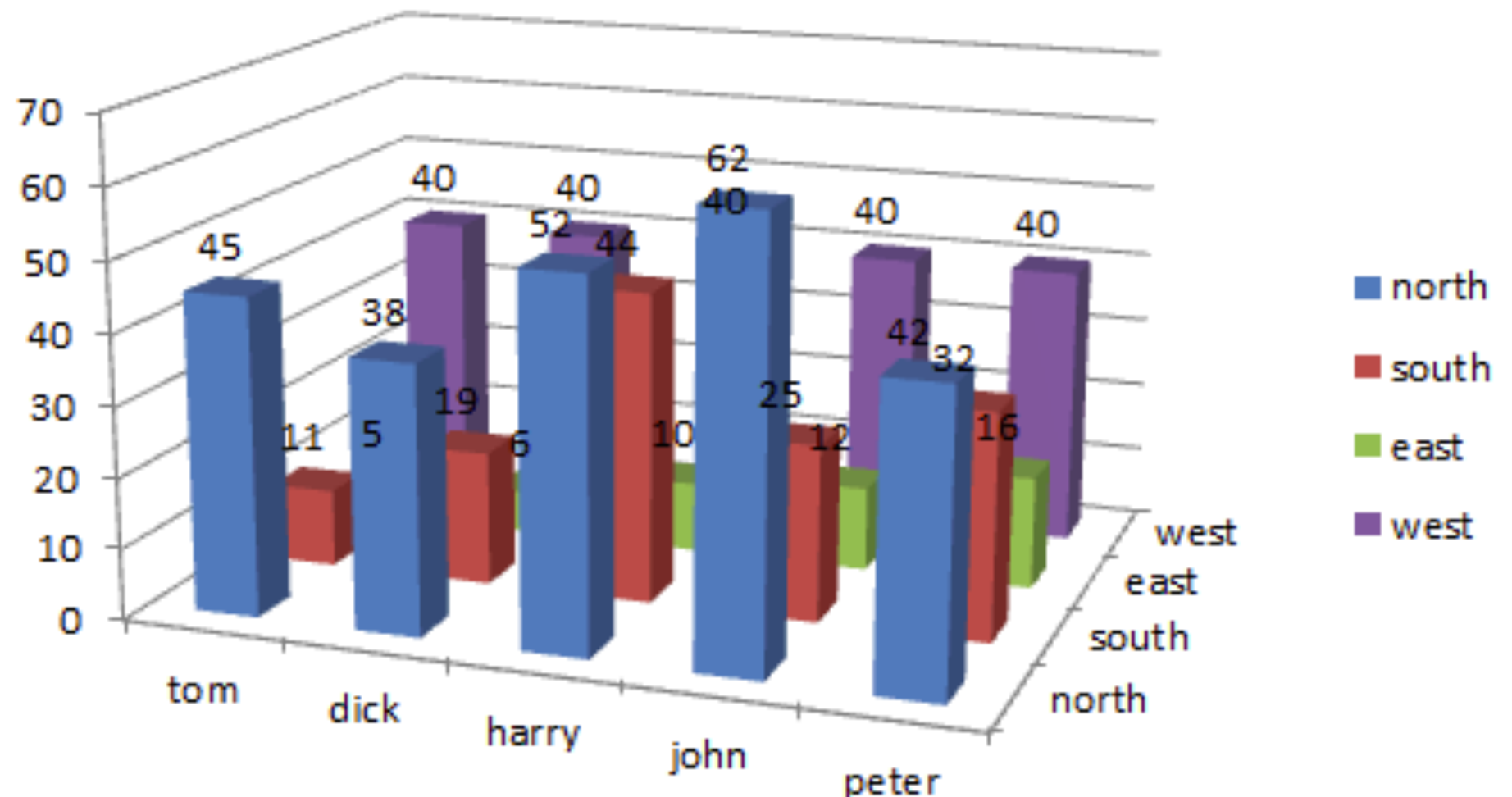
3D is ok only if data is



Kindlmann et al., 2003, Curvature-based transfer functions

Don't use 3D when data isn't 3D

- Perspective interacts with size and color judgments
- Occlusion is bad, often unnecessary

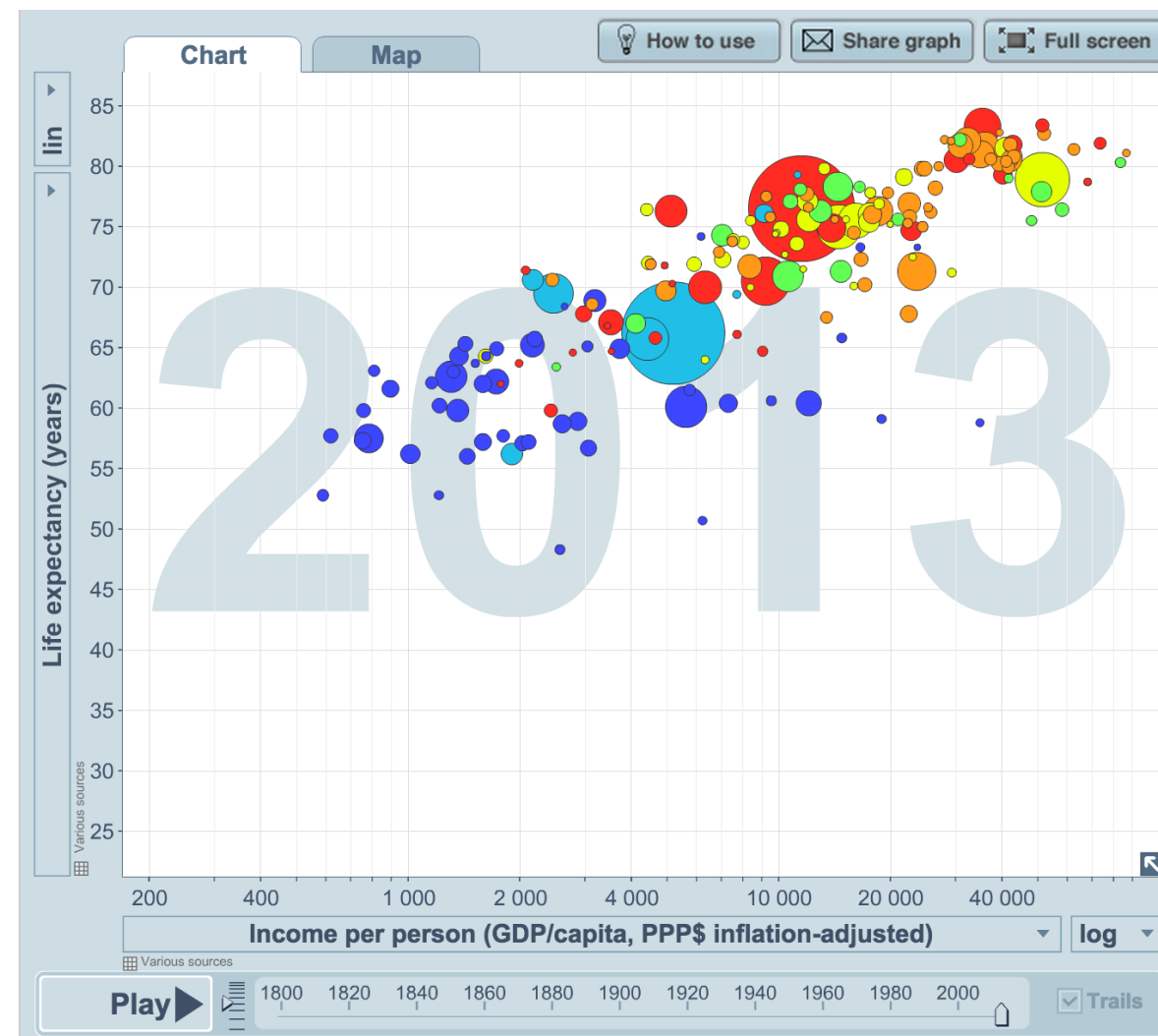


Animations

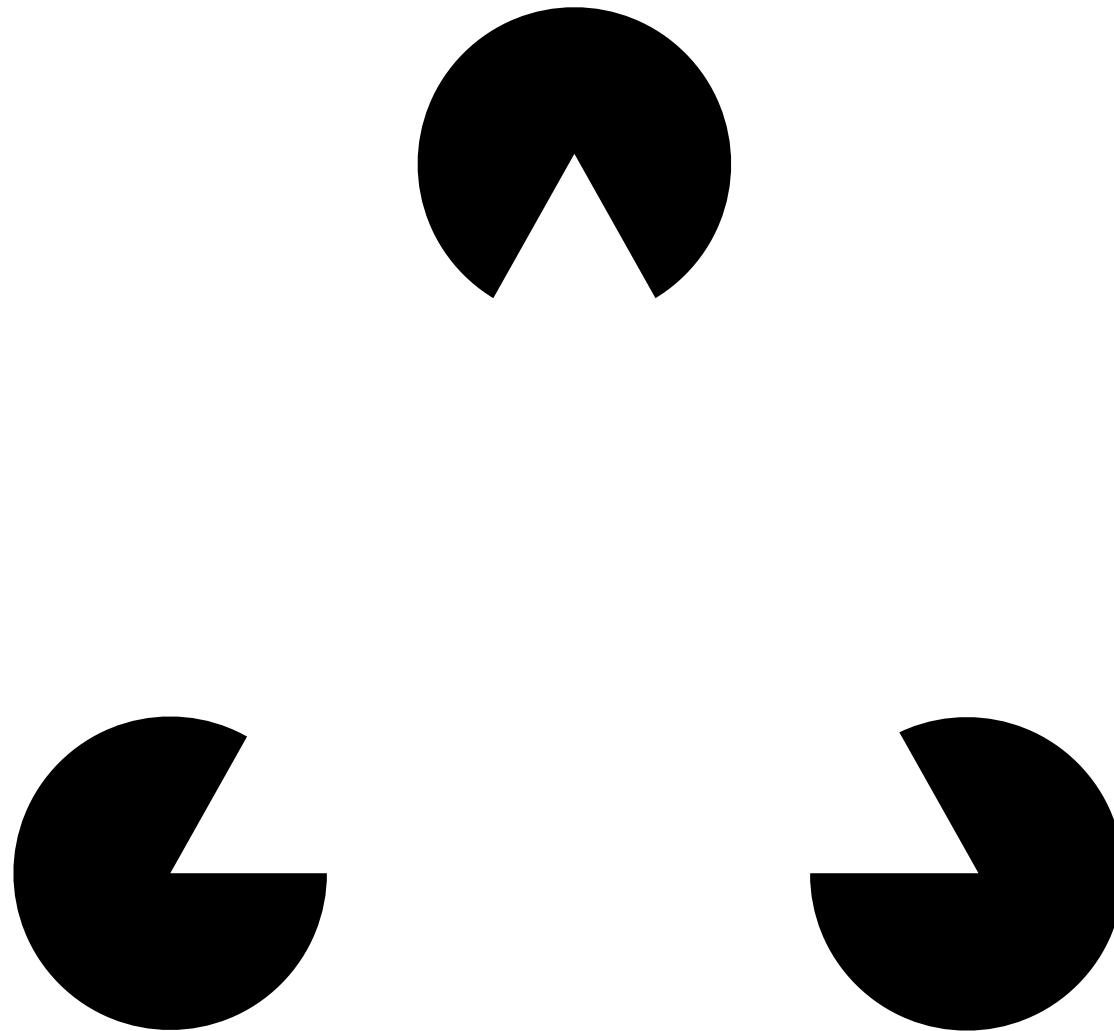
- We perceive motion, and regularity, even when none might be intended
- <https://cscheid.net/projects/illusions/purple-dots/>
- And it interacts badly with the rest of our perceptual system

Animations

- limit them to **data transitions**, preferably controlled by interaction



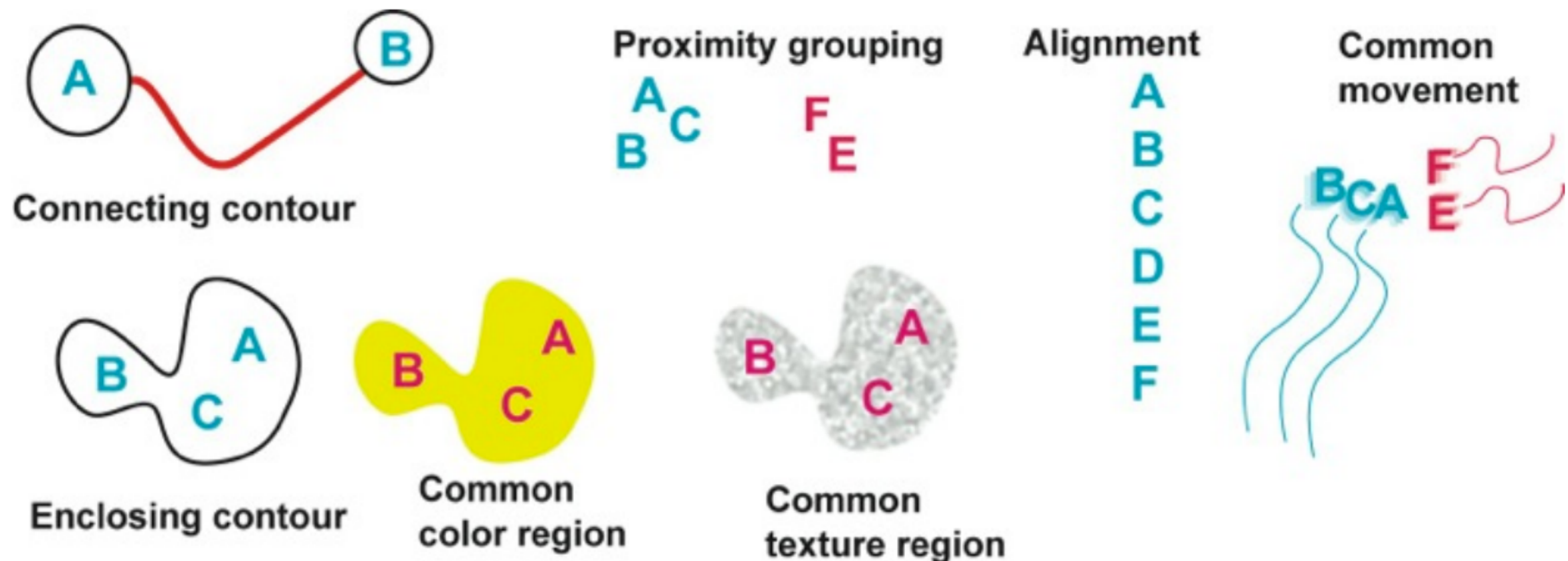
www.gapminder.org



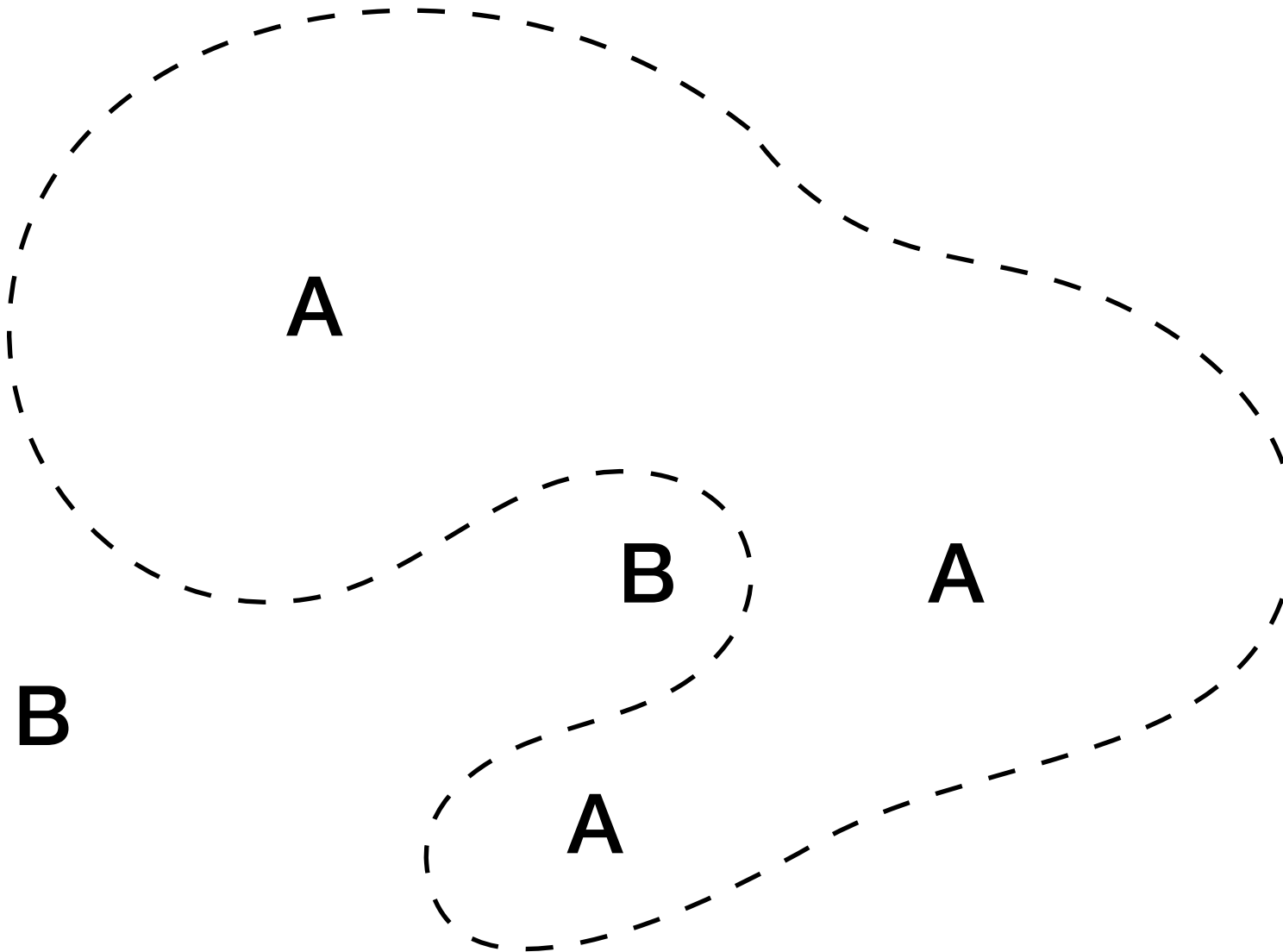
GESTALT PRINCIPLES

GESTALT PRINCIPLES

- General idea: we interpret stimuli as patterns that are grouped, complete, whole
- Even when they aren't



GESTALT: CONTAINMENT



Objects inside closed shapes appear related, even when they're far apart

GESTALT: CONTAINMENT



IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS, VOL. 15, NO. 6, NOVEMBER/DECEMBER 2009

1009

Bubble Sets: Revealing Set Relations with Isocontours over Existing Visualizations

Christopher Collins, Gerald Penn, and Sheelagh Carpendale

Abstract—While many data sets contain multiple relationships, depicting more than one data relationship within a single visualization is challenging. We introduce Bubble Sets as a visualization technique for data that has both a primary data relation with a semantically significant spatial organization and a significant set membership relation in which members of the same set are not necessarily adjacent in the primary layout. In order to maintain the spatial rights of the primary data relation, we avoid layout adjustment techniques that improve set cluster continuity and density. Instead, we use a continuous, possibly concave, isocontour to delineate set membership, without disrupting the primary layout. Optimizations minimize cluster overlap and provide for calculation of the isocontours at interactive speeds. Case studies show how this technique can be used to indicate multiple sets on a variety of common visualizations.

Index Terms—clustering, spatial layout, graph visualization, tree visualization.

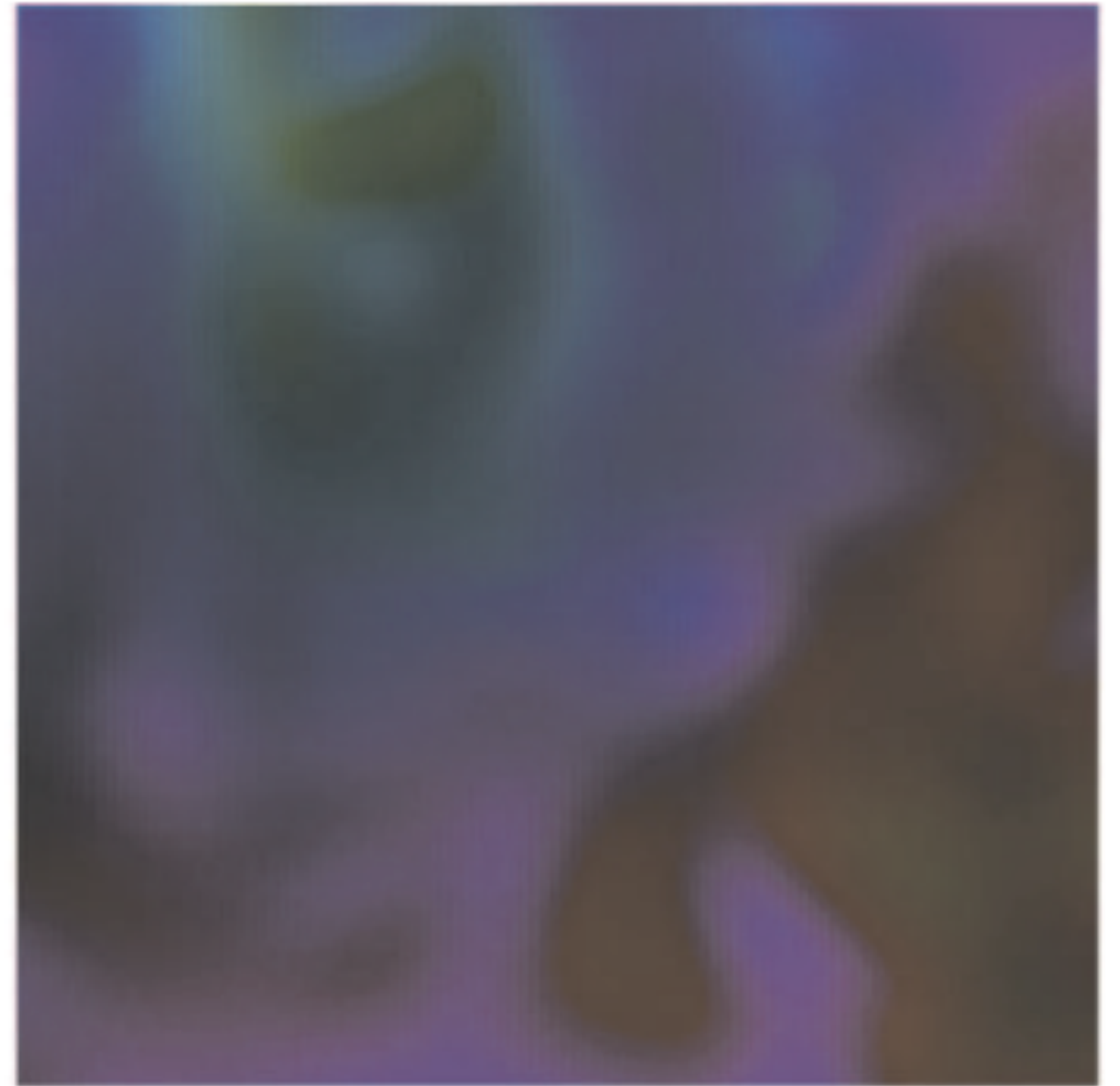


HIGHER-LEVEL CHANNELS
WE ARE STILL STUDYING

Overlays for bivariate maps

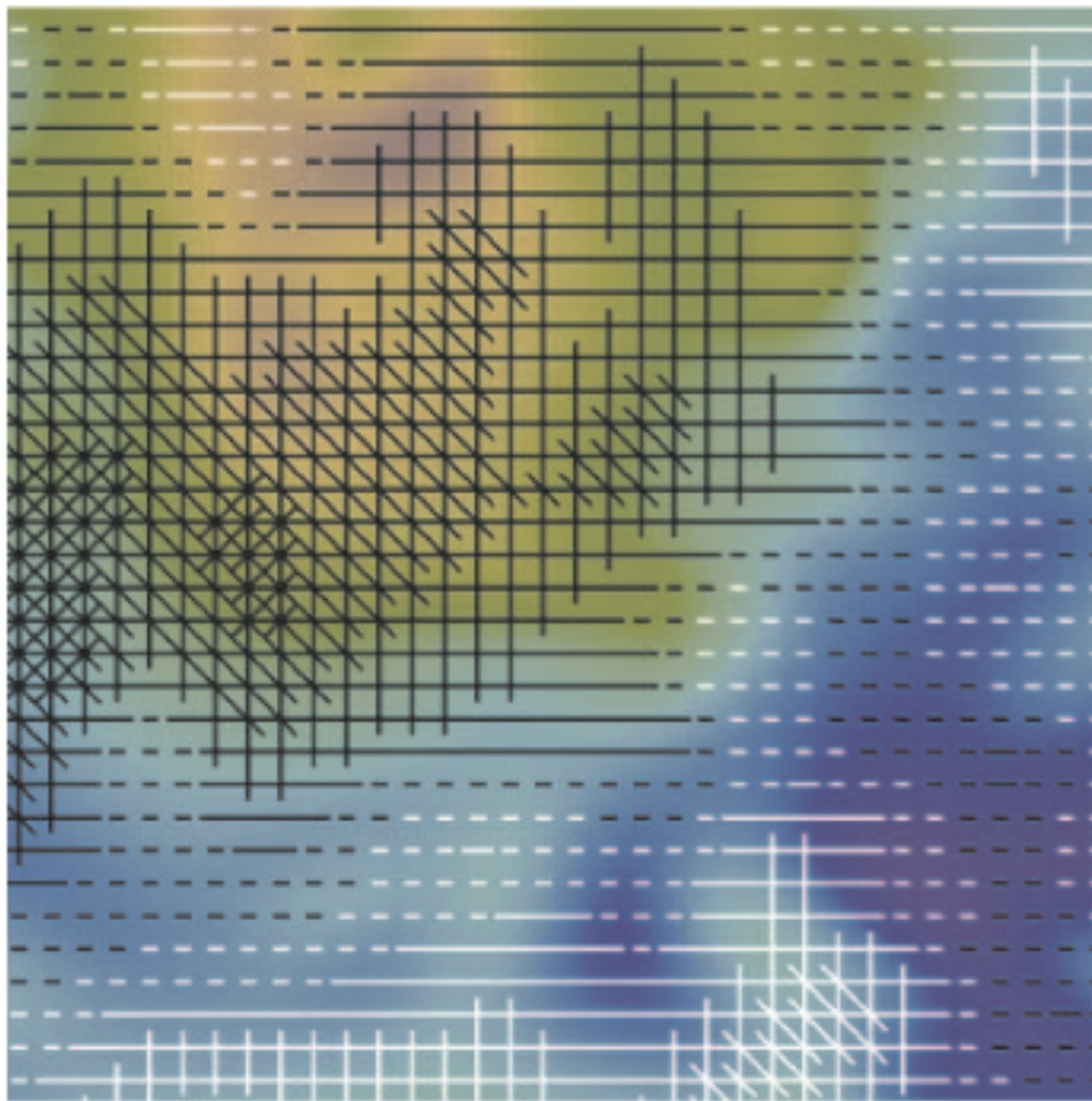


Scheme 1: Green Red (GR)

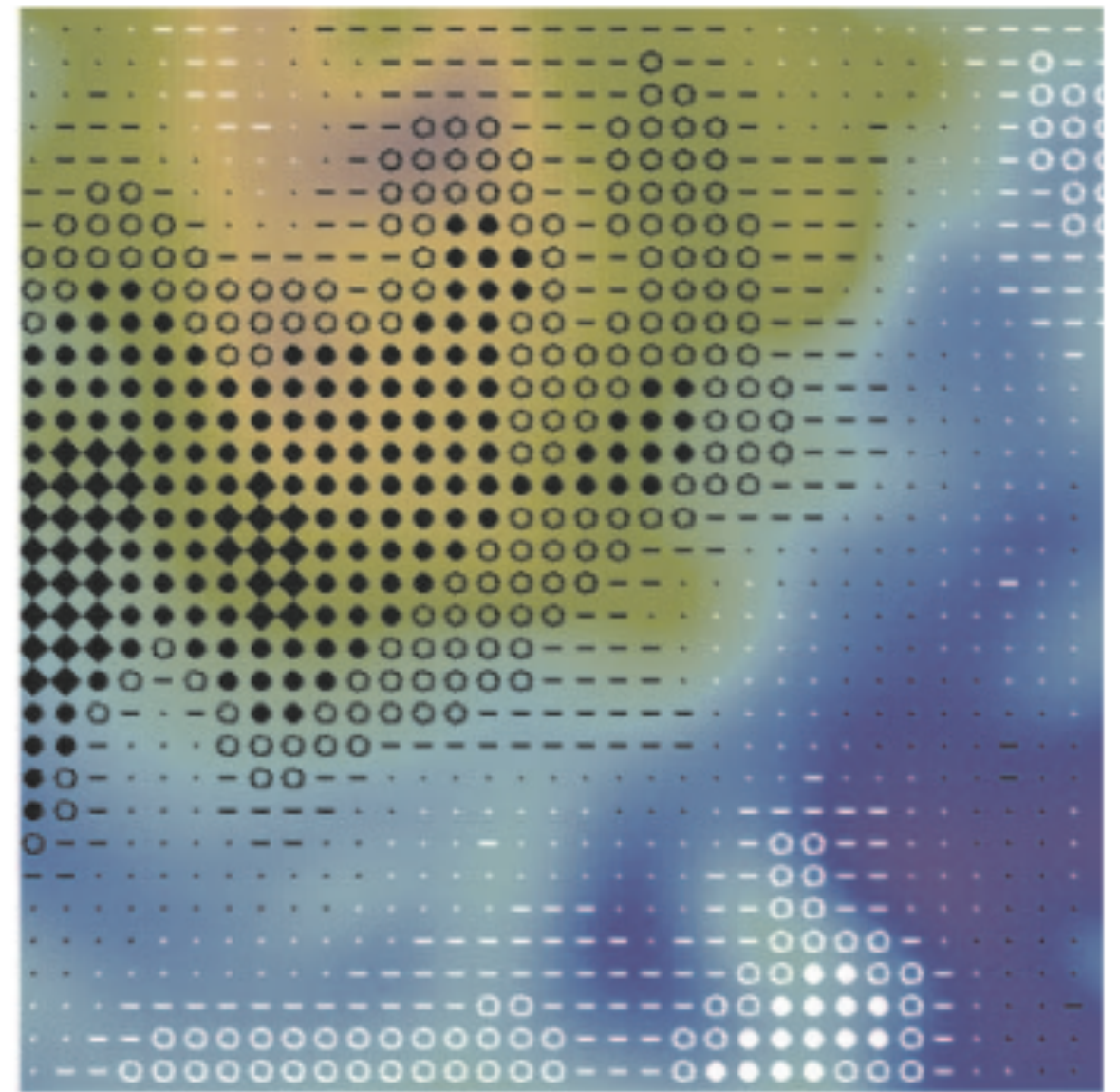


Scheme 2: Hue Lightness (HL)

Overlays for bivariate maps



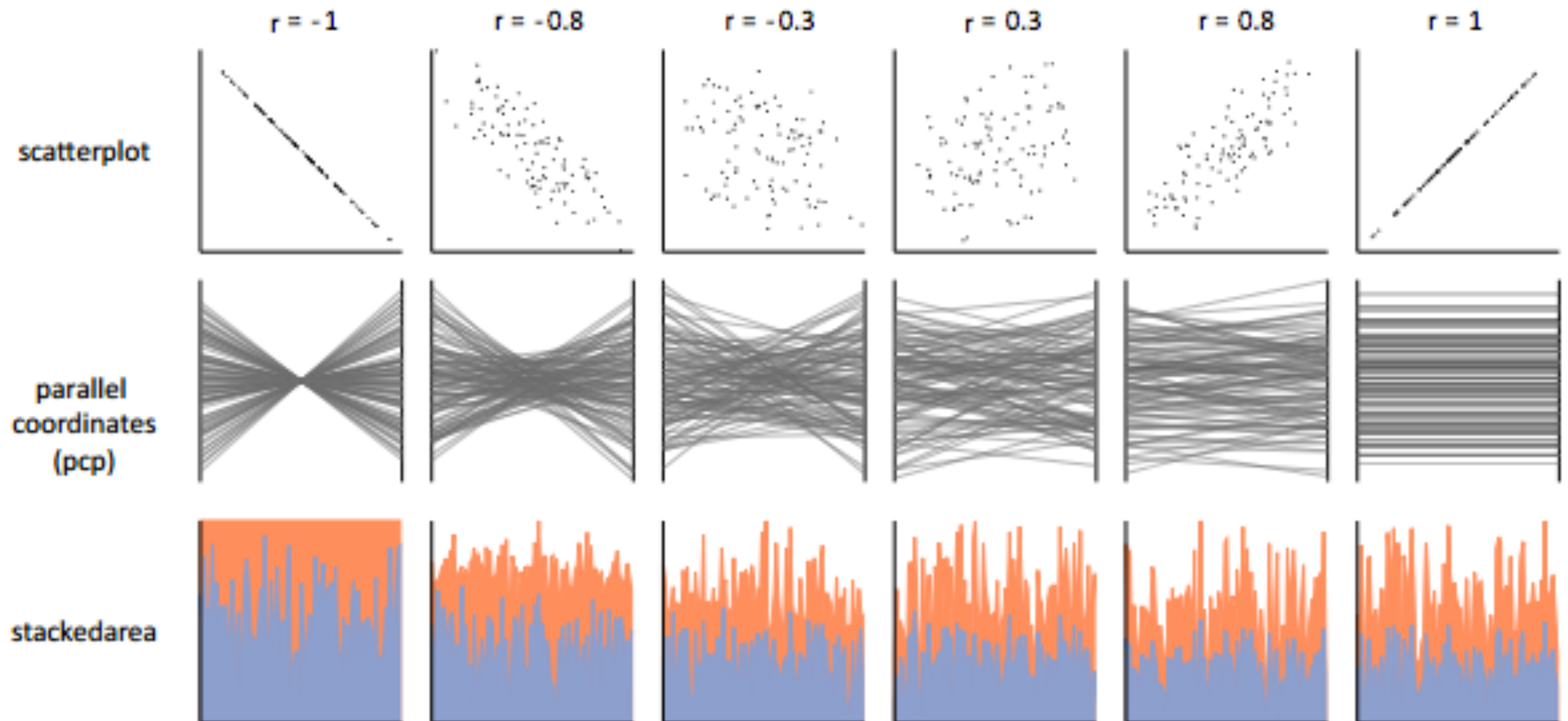
Scheme 4: Spectrum QTonS 1 (QTS_1)



Scheme 5: Spectrum QTonS 2 (QTS_2)

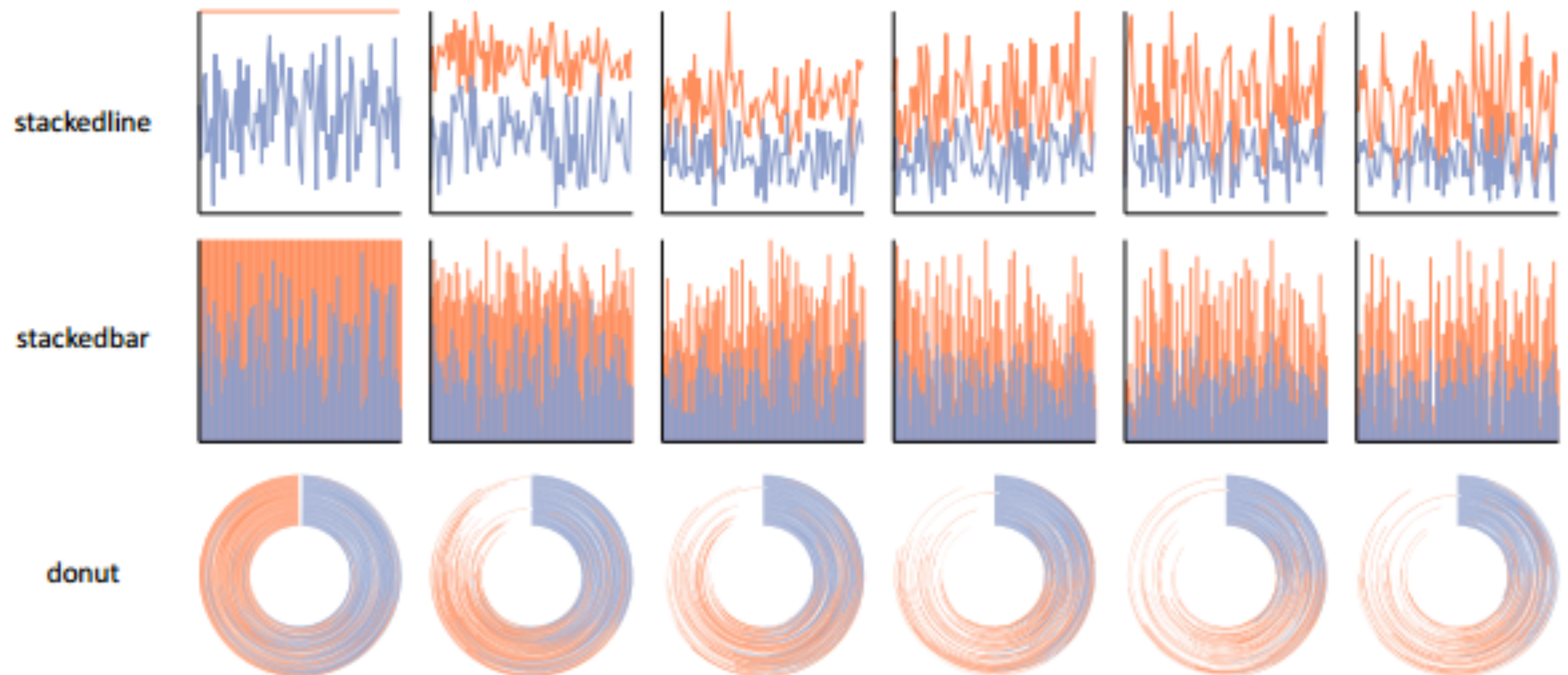
Perception of higher-level features

- Correlation perception follows Weber's Law (!)



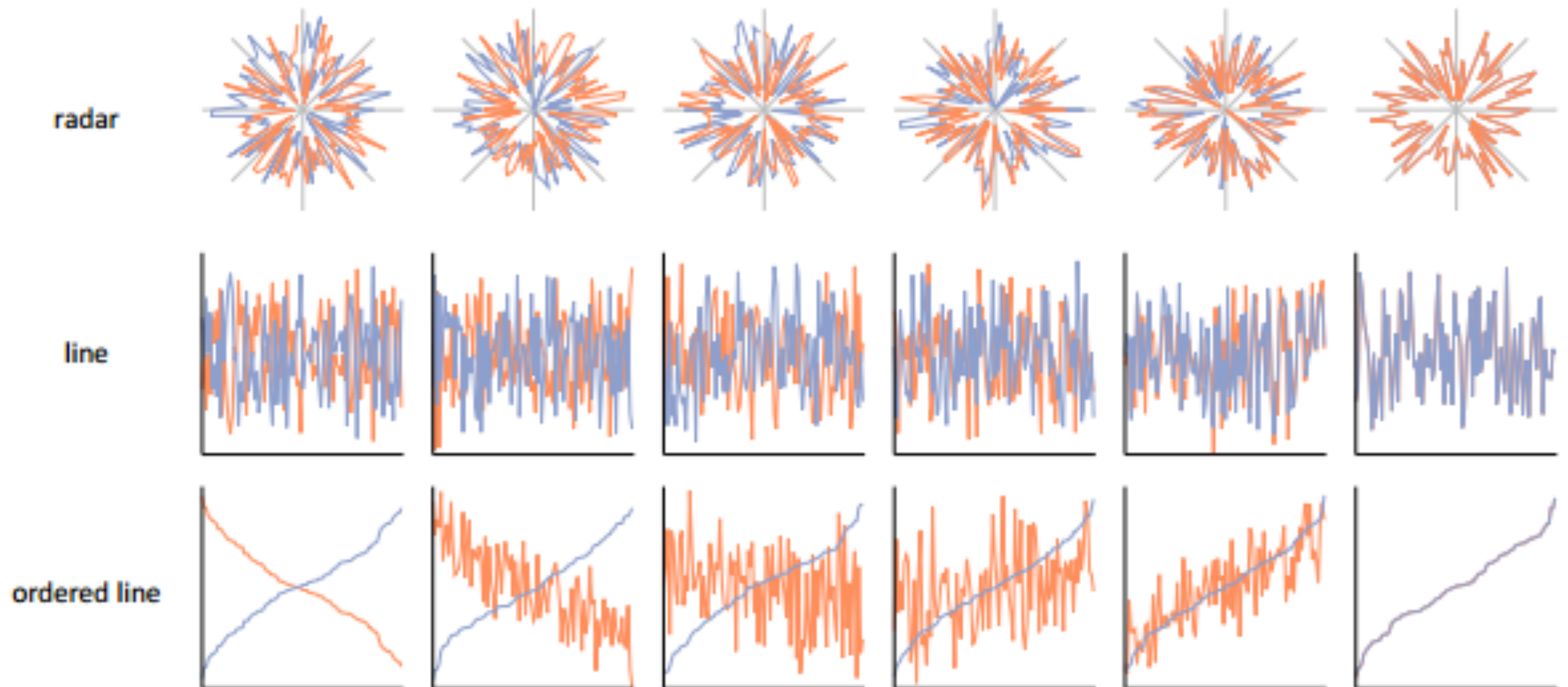
Perception of higher-level features

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Perception of higher-level features

- Correlation perception follows Weber's Law (!)



Recap

- **Consider how data behaves**
 - Can you add? Subtract? Compare?
 - Is there a smallest, or a neutral value?
 - Is there a notion of “negative”?
 - Are values just different from one another?
- **Consider how visual channels behave**
- **then match the two appropriately**

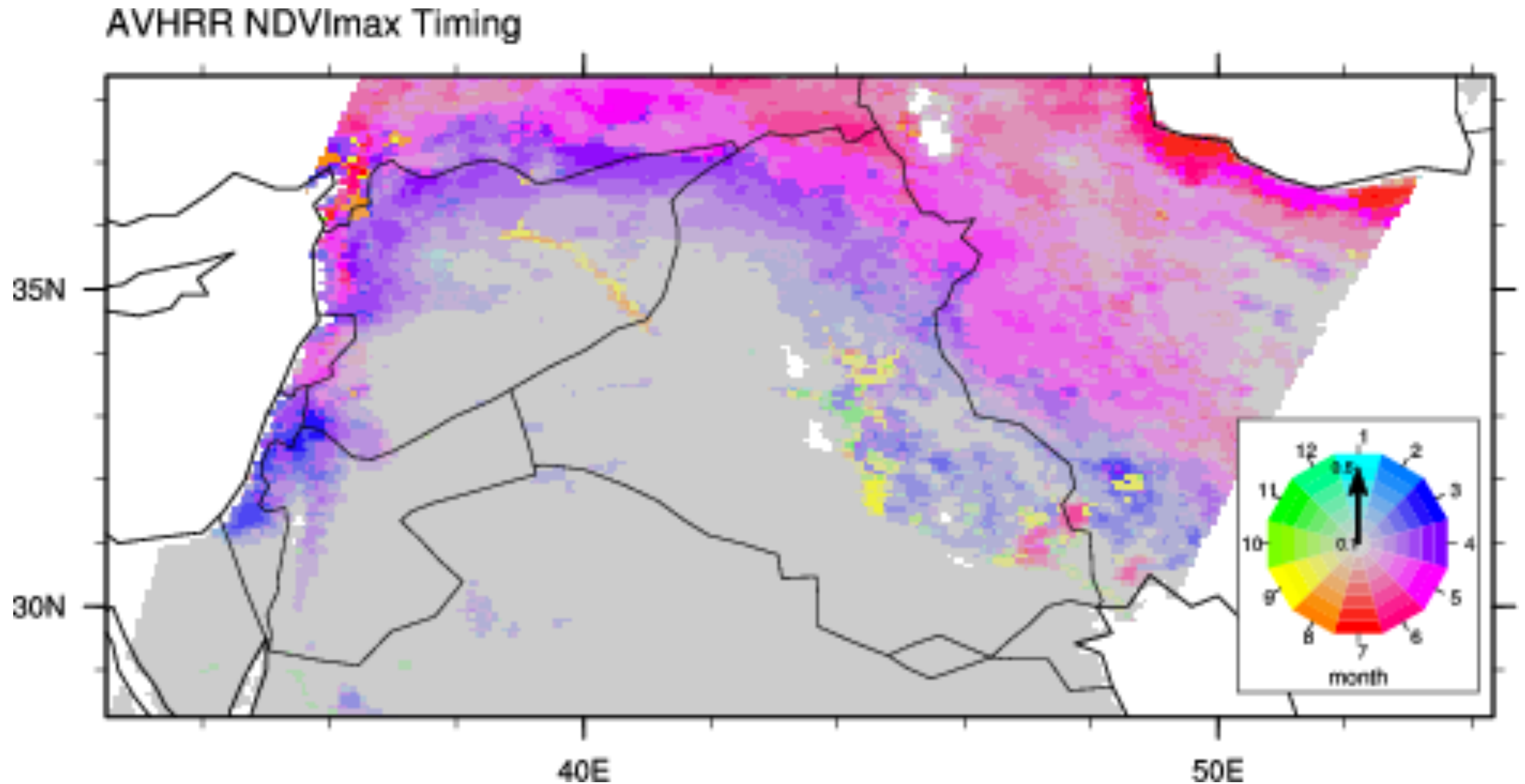
- Consider how the basic visual channels behave, match the two appropriately

What if they don't match?

“WEIRD” DATA

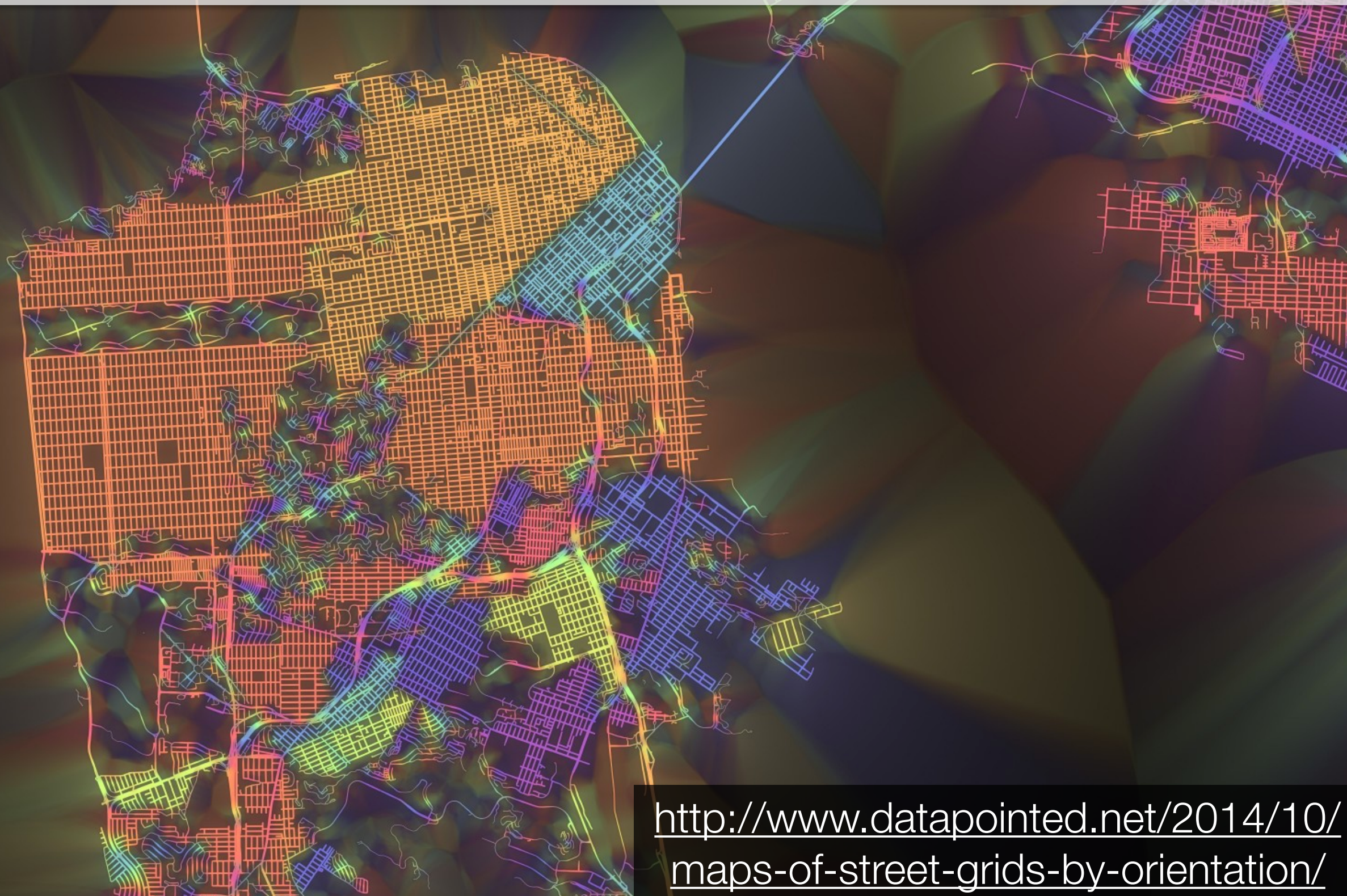
(A prelude to techniques)

Orientation vs. Direction



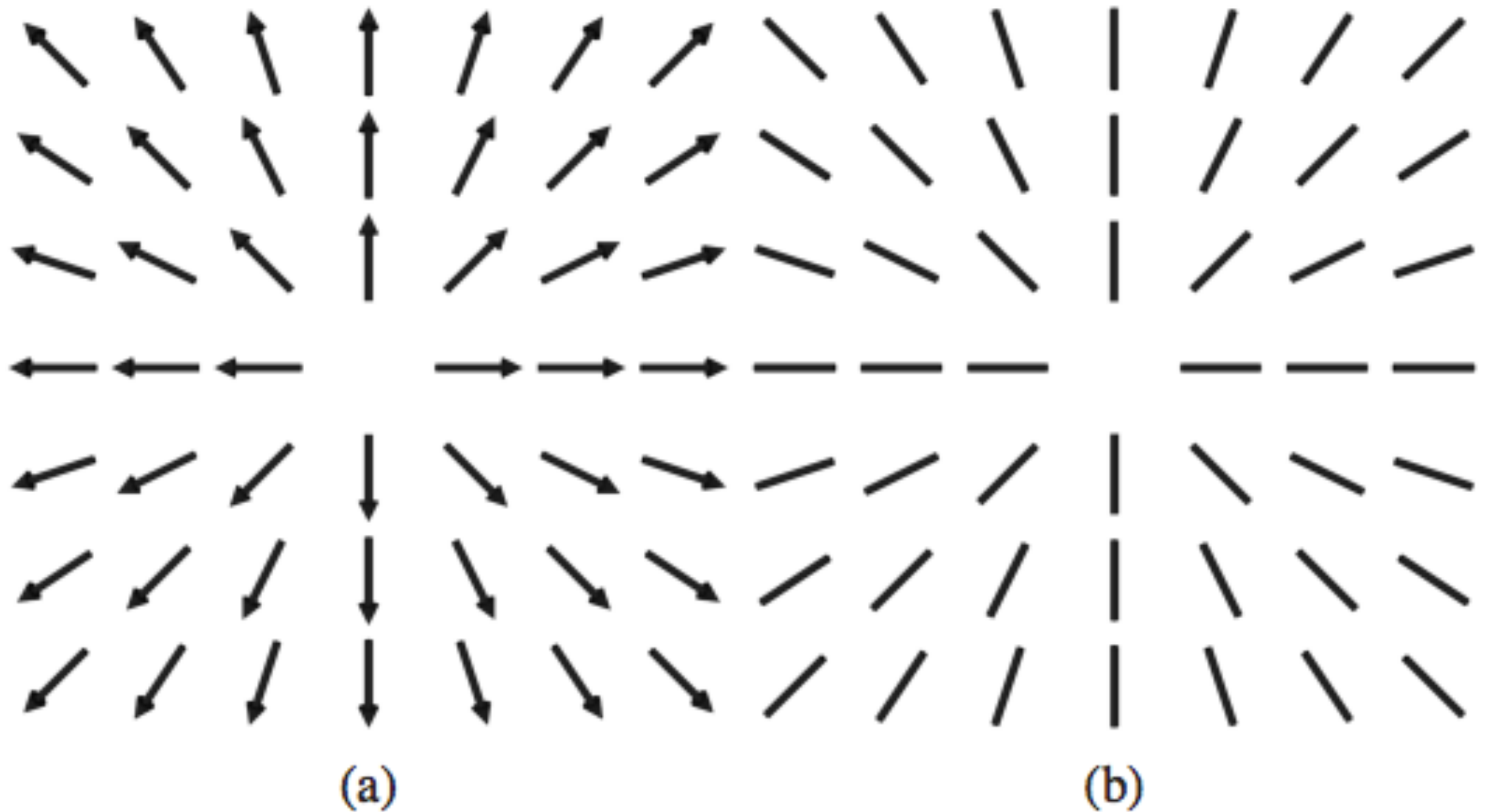
<https://www.ncl.ucar.edu/Applications/evans.shtml>

Orientation vs. Direction



<http://www.datapointed.net/2014/10/maps-of-street-grids-by-orientation/>

Direction vs. Orientation



Extra slides

Simpson's “Paradox”

Table 1: Change in Median Wage by Education from 2000 to 2013

Segment	Change in Median Wage (%)
Overall	+0.9%
No degree	-7.9%
HS, no college	-4.7%
Some college	-7.6%
Bachelor's +	-1.2%

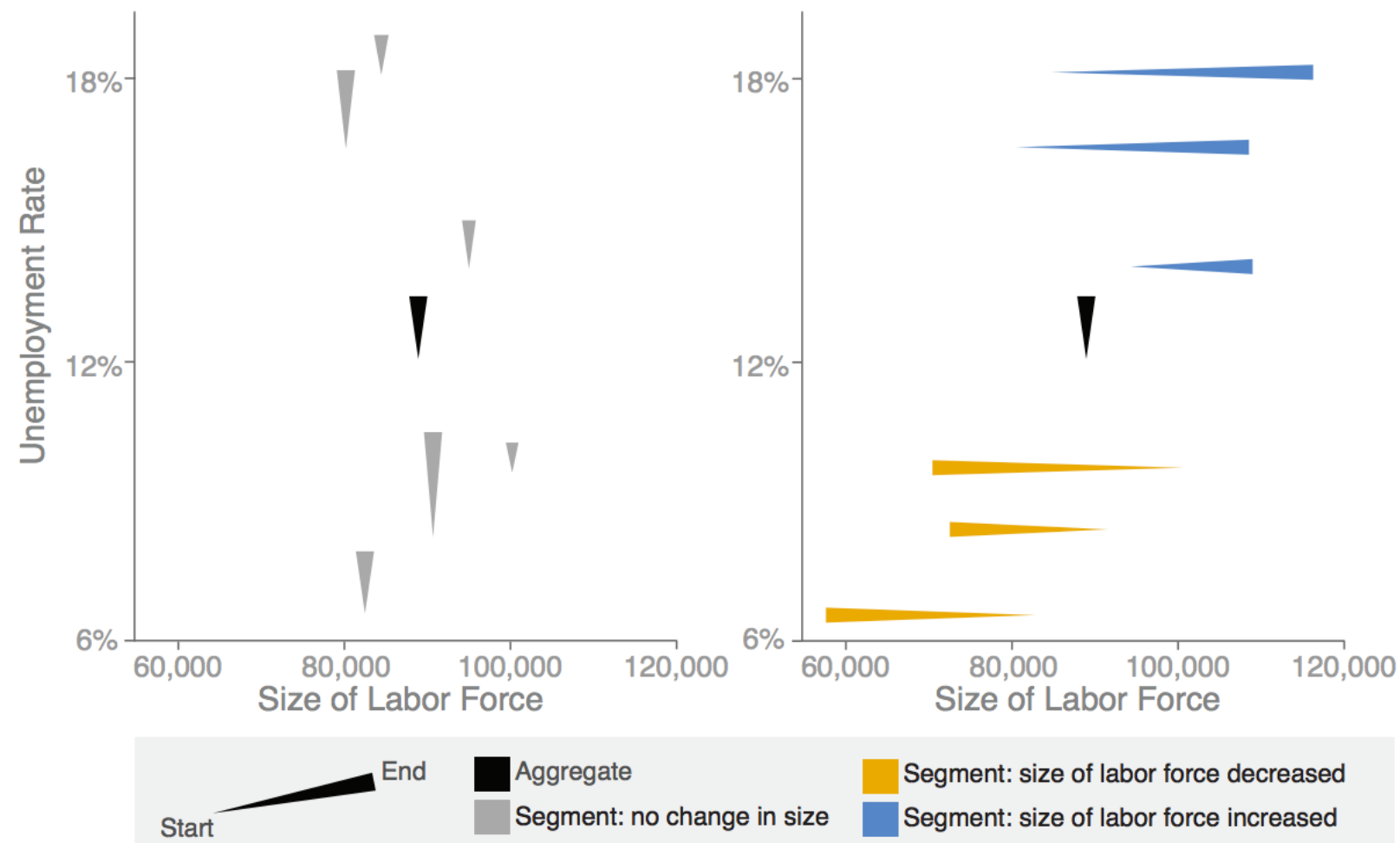
Simpson's “Paradox”

Segment	Employed 2000	Employed 2013	Change (%)
Overall	89.4	95.0	+6.4%
No degree	8.8	7.0	-21.3%
HS, no college	28.0	25.0	-10.6%
Some college	24.7	26.0	+5.4%
Bachelor's +	27.8	37.0	+33.0%

Simpson's “Paradox”

Visualizing Statistical Mix Effects and Simpson's Paradox

Zan Armstrong and Martin Wattenberg



Probability Distributions

- Map behavior of conditional distributions, marginal distributions, etc. to visual channels: Product Plots, Wickham and Hoffman, TVCG 2011

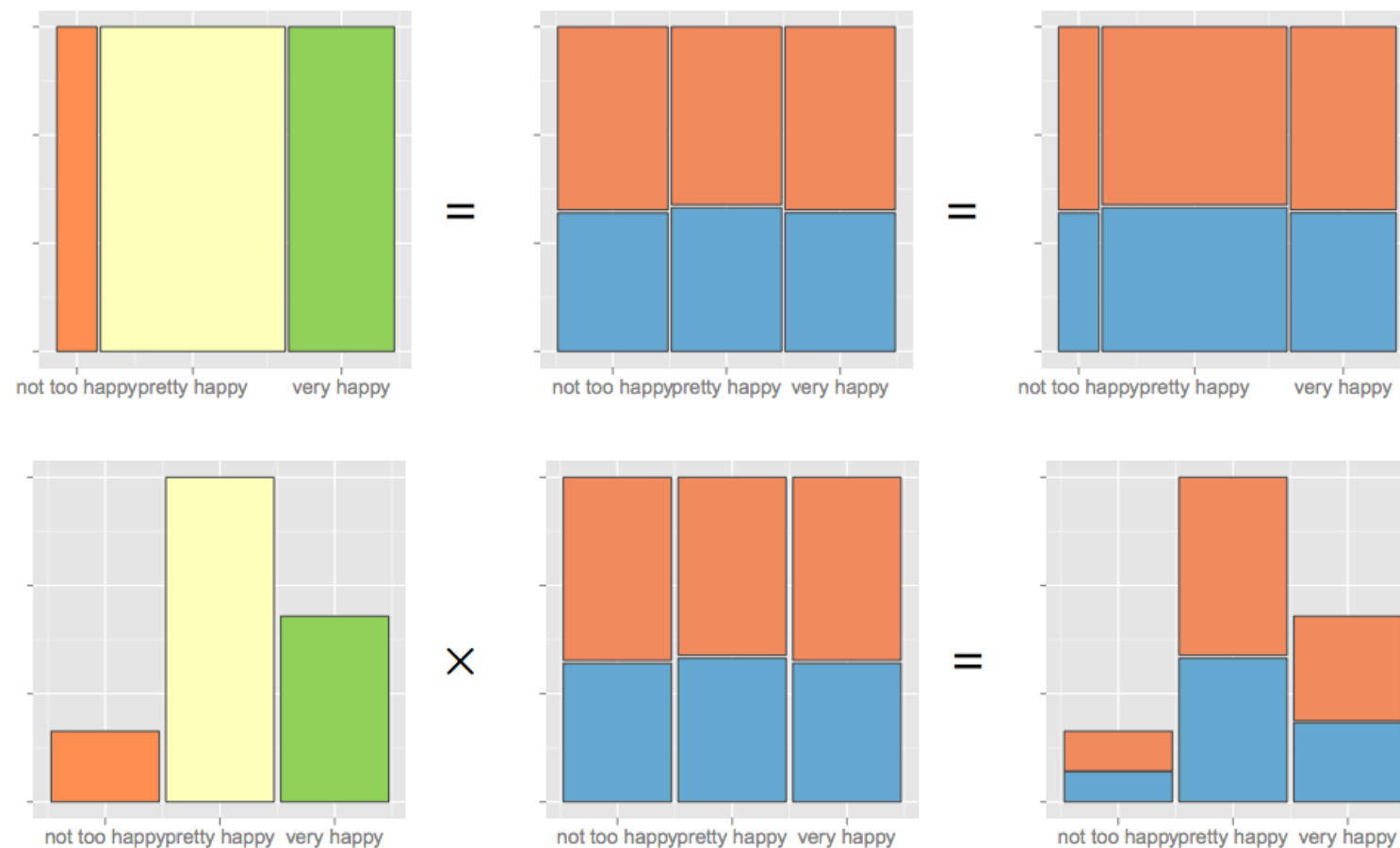
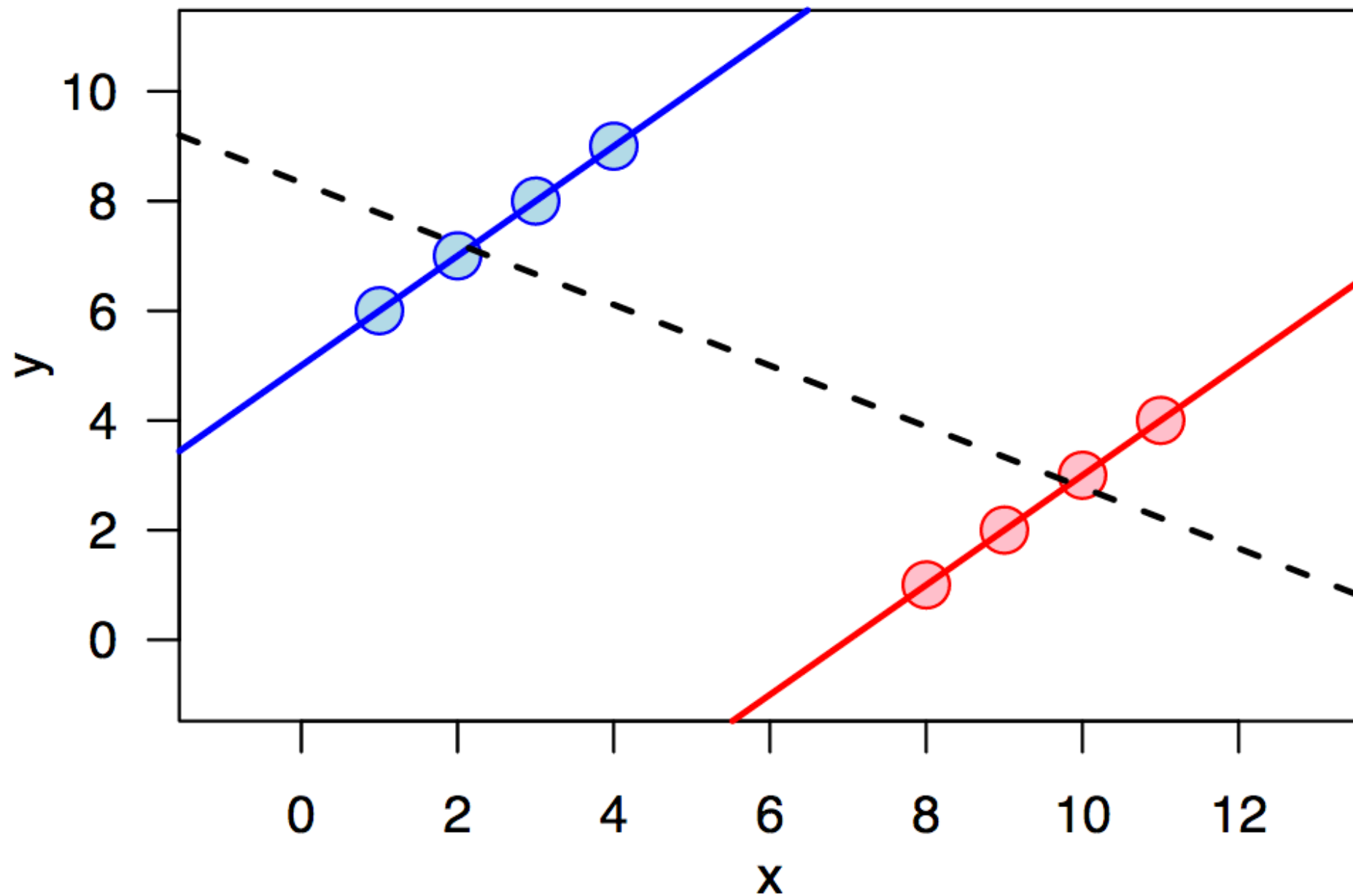


Fig. 5. Plots of the distribution of happiness and sex (■ male, ■ female)
(Left) $f(\text{happy})$, (Middle) $f(\text{sex}|\text{happy})$, (Right) $f(\text{happy}, \text{sex})$.

Simpson's “Paradox”



GESTALT: SIMILARITY



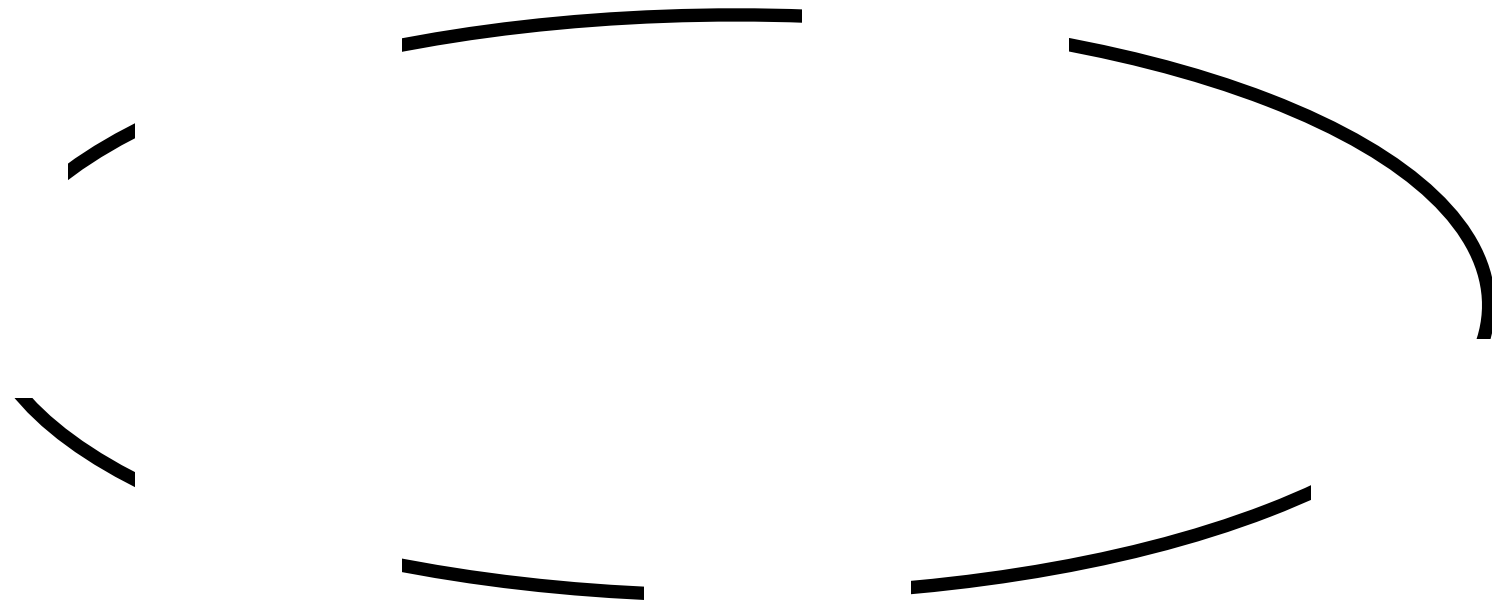
We use color to connect things into groups

GESTALT: PROXIMITY



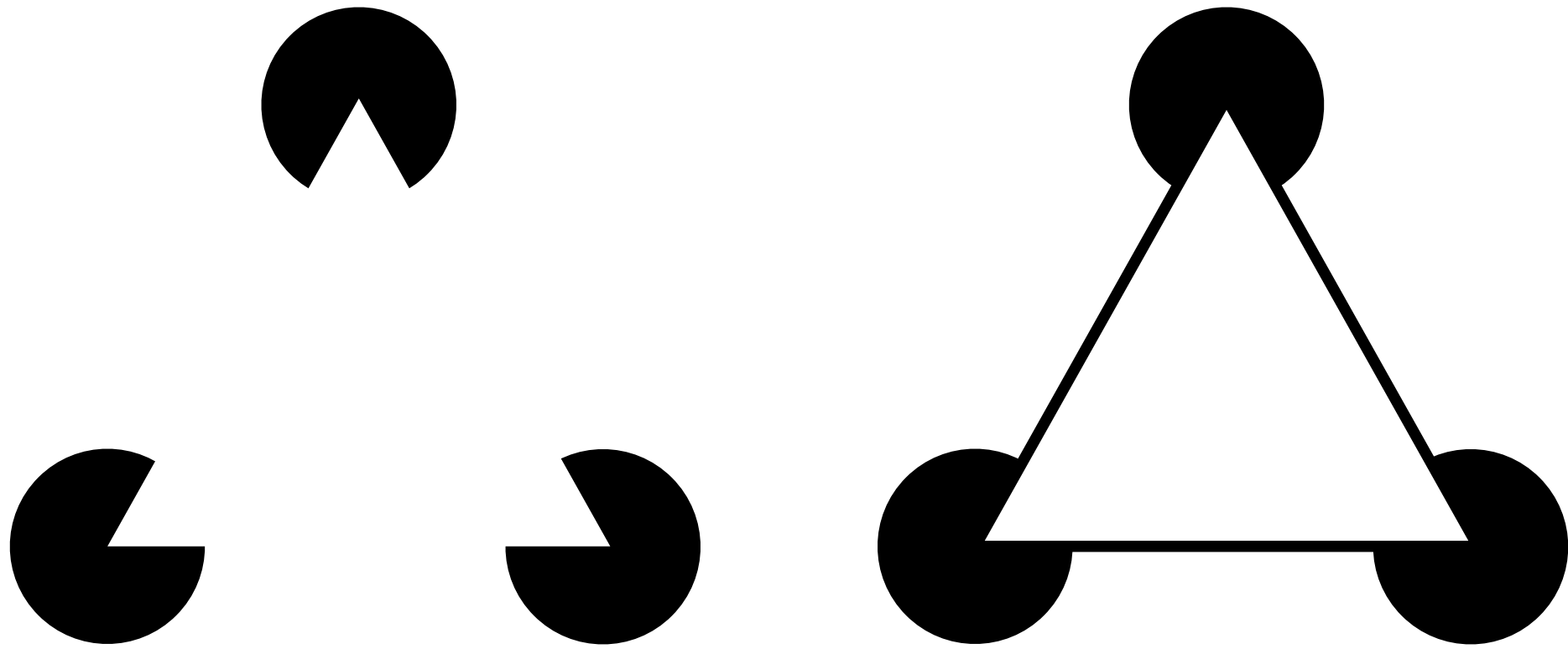
We use distance to connect things into groups

GESTALT: CLOSURE



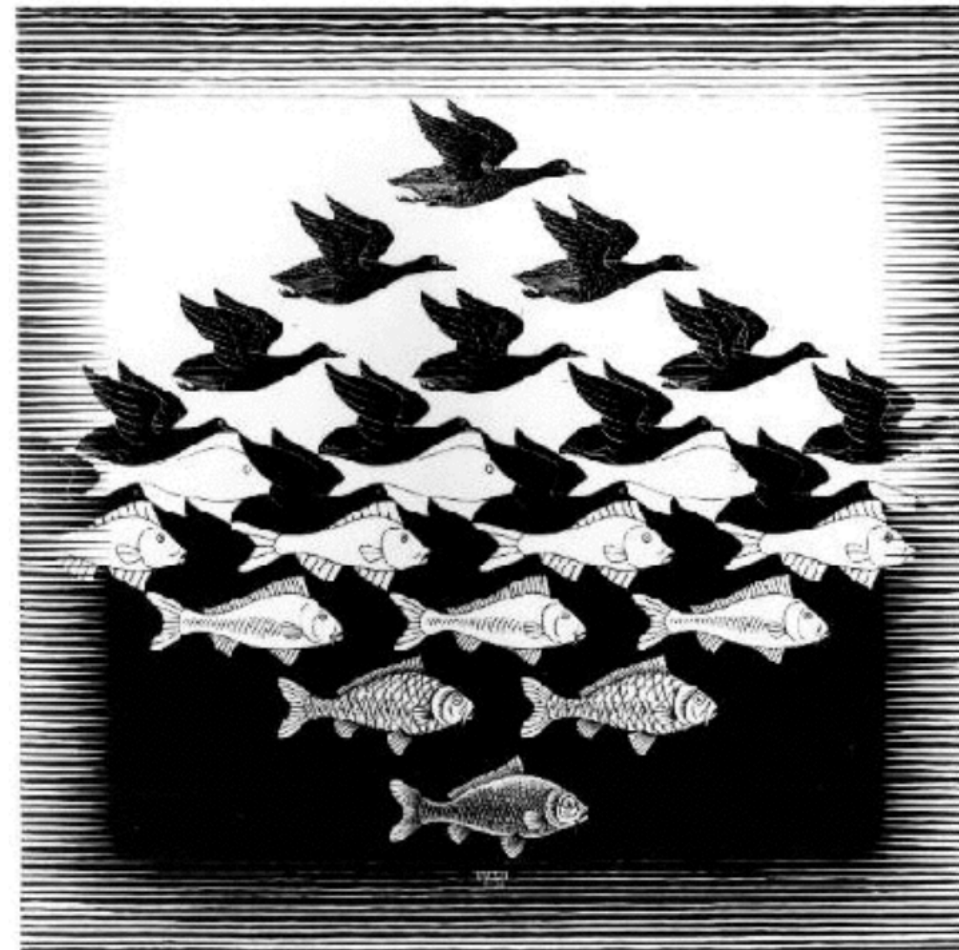
We see closed shapes, even when they're not there

GESTALT: CONTINUITY



We see simple, connected figure/ground shapes rather than complicated shapes

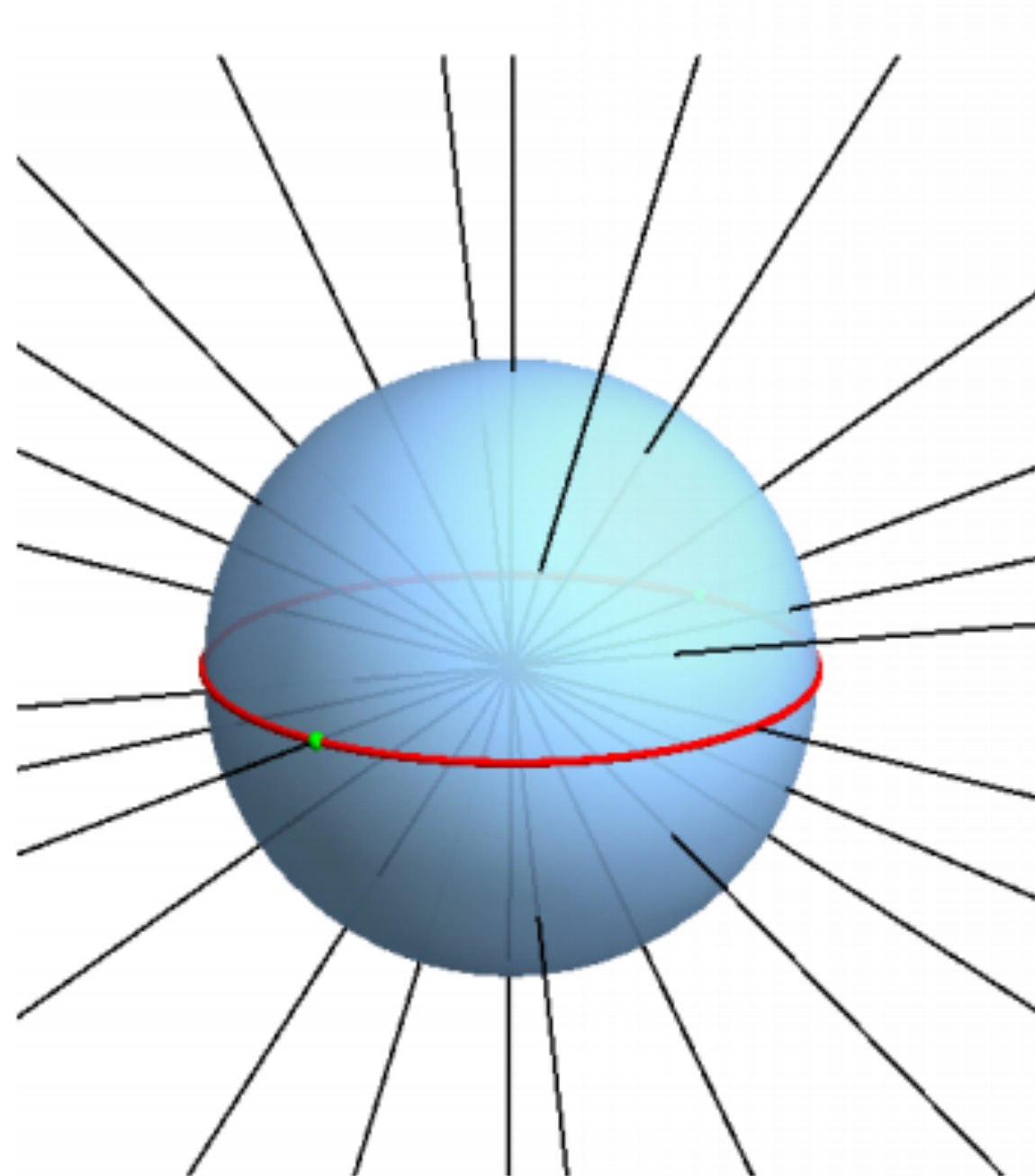
GESTALT: FIGURE/GROUND



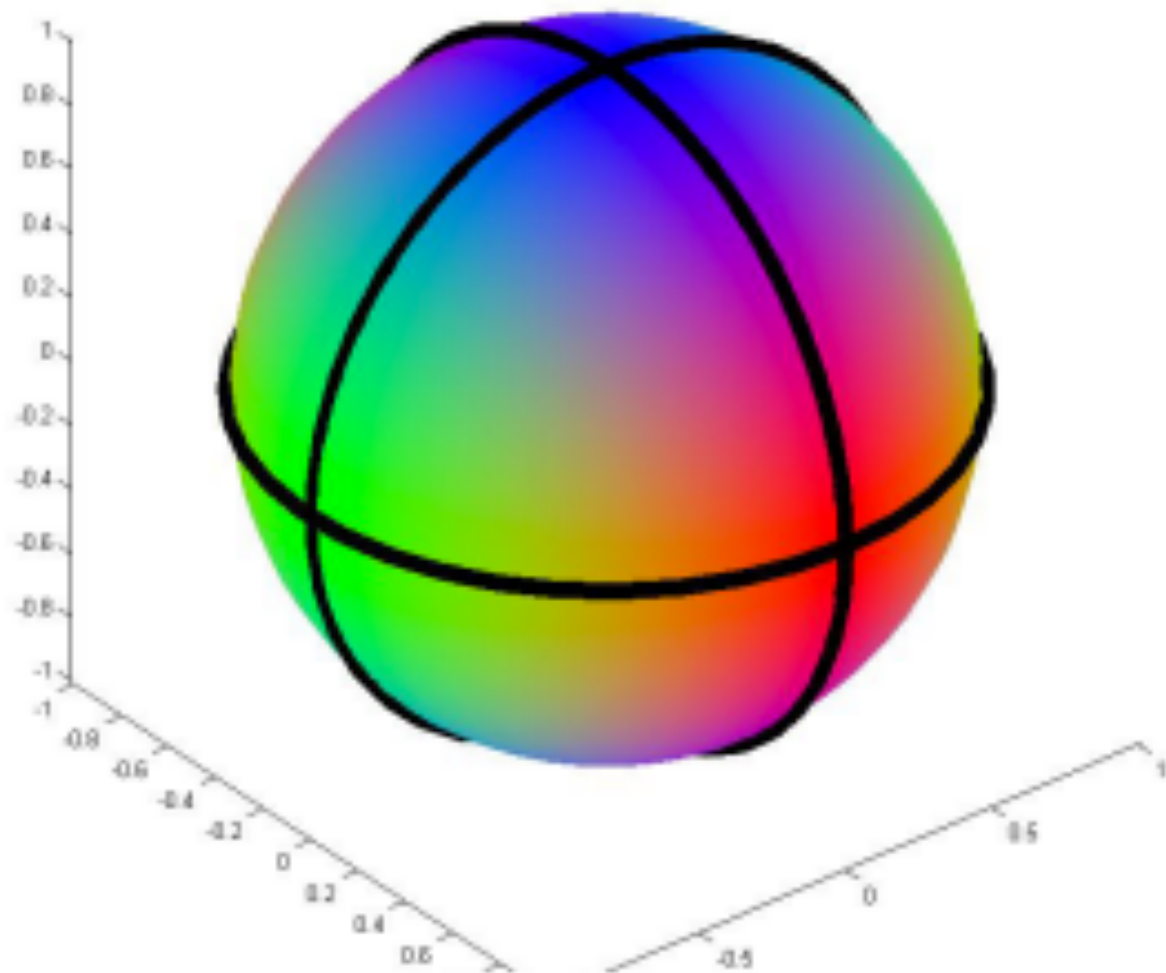
M.C. Escher: *Sky and Water I* 1938 woodcut

We see simple, connected figure/ground shapes rather than complicated shapes

Orientation vs. Direction



Orientation vs. Direction

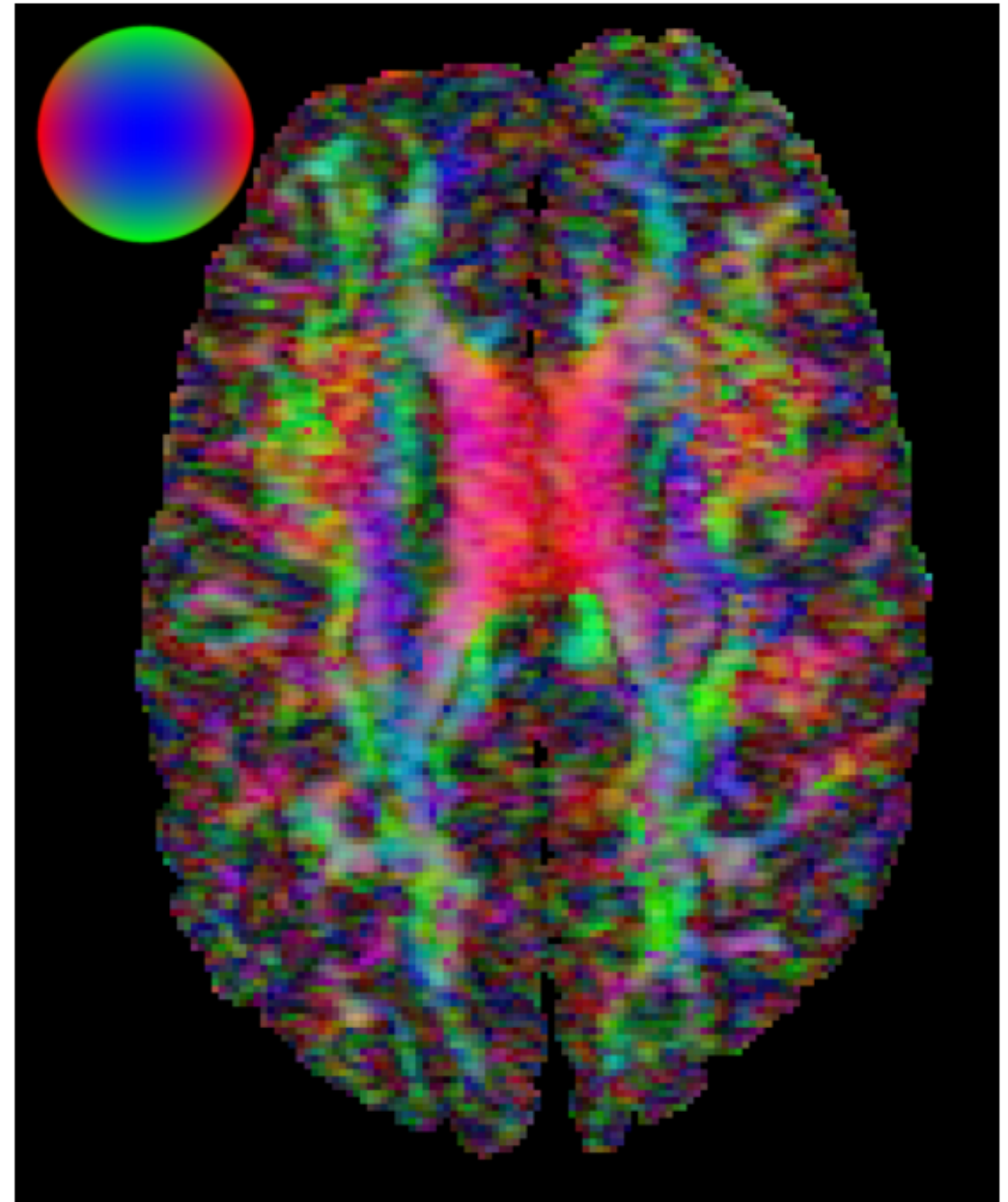


(c)

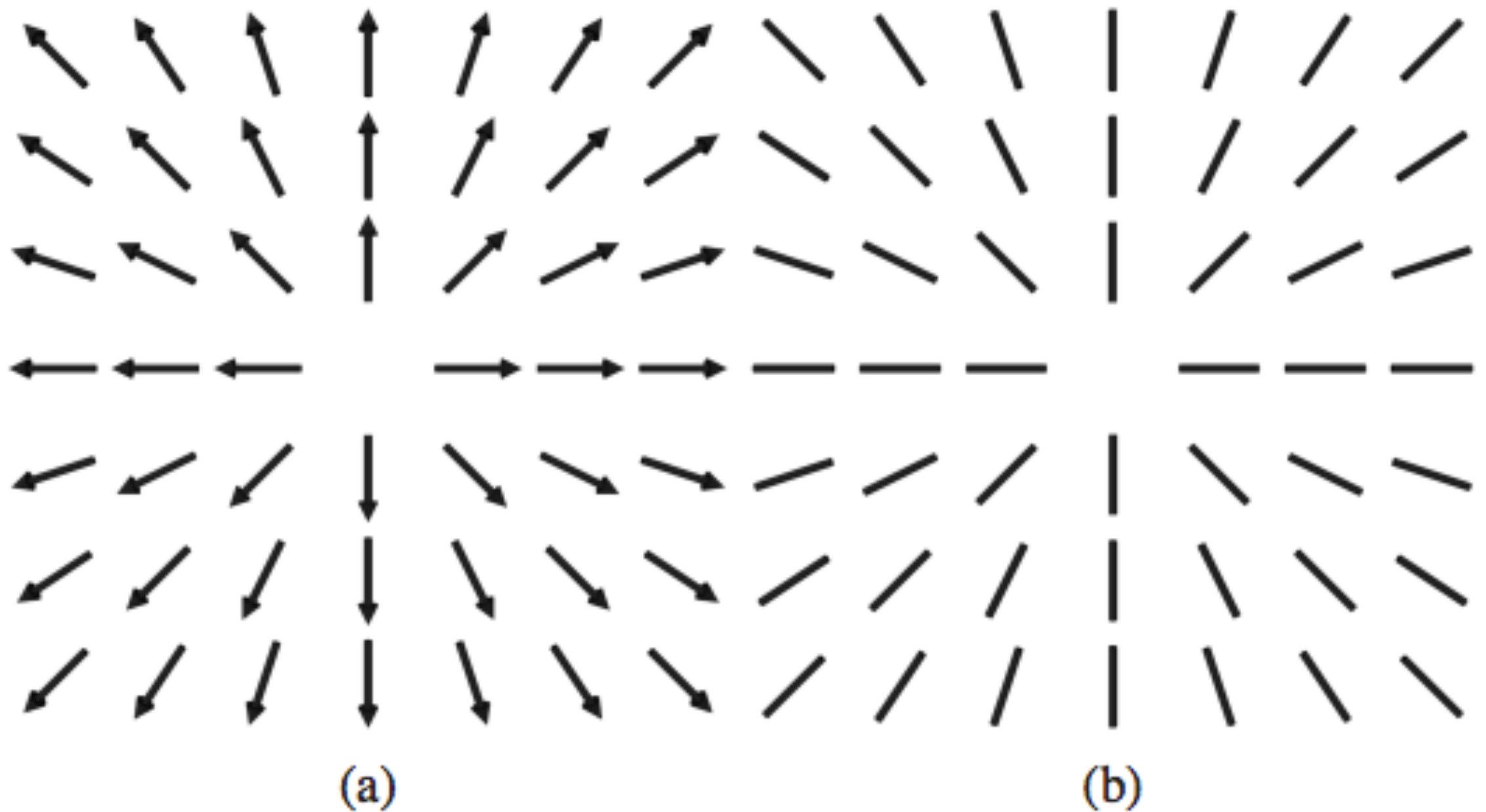
This is a bad colormap.

Why?

Orientation vs. Direction



Orientation vs. Direction



Orientation vs. Direction

Coloring 3D Line Fields Using Boy's Real Projective Plane Immersion

Çağatay Demiralp, John F. Hughes, and David H. Laidlaw, *Senior Member, IEEE*

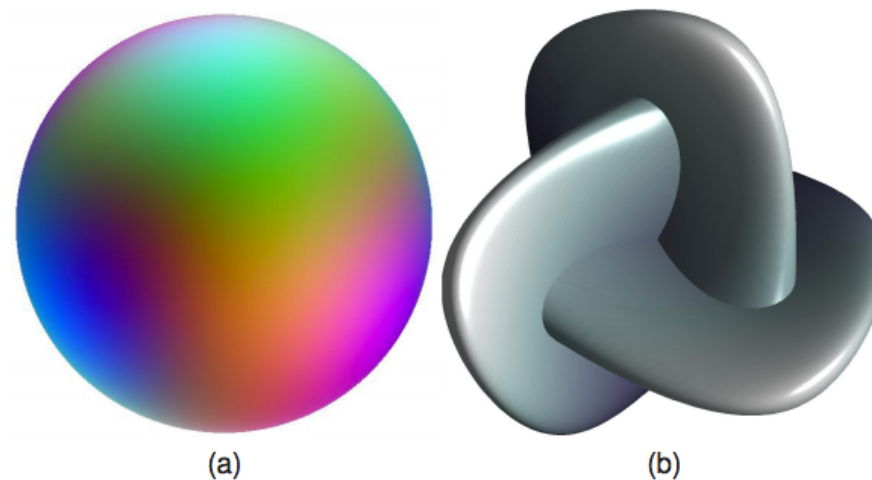


Fig. 1: a) Sphere colored by immersing RP^2 in RGB color space b) Boy's surface

Abstract—We introduce a new method for coloring 3D line fields and show results from its application in visualizing orientation in DTI brain data sets. The method uses Boy's surface, an immersion of RP^2 in 3D. This coloring method is smooth and one-to-one except on a set of measure zero, the double curve of Boy's surface.

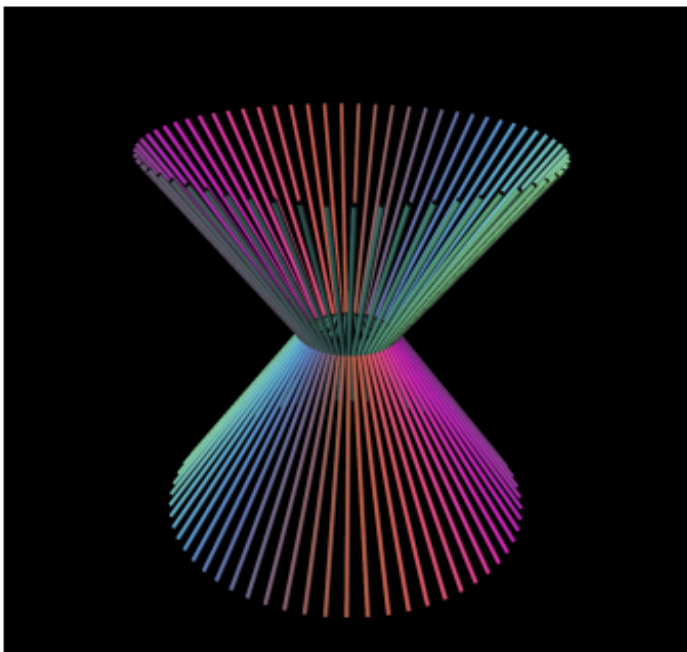
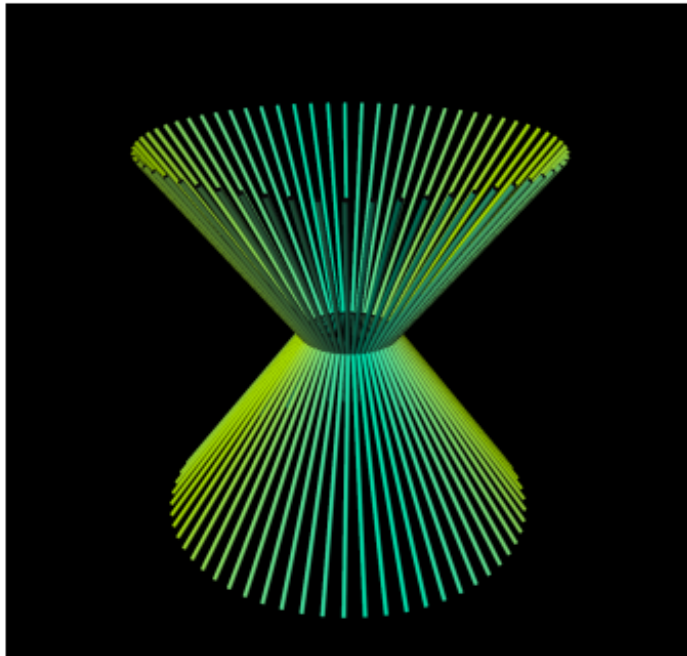
Index Terms—Line field, colormapping, orientation, real projective plane, tensor field, DTI.

1 INTRODUCTION

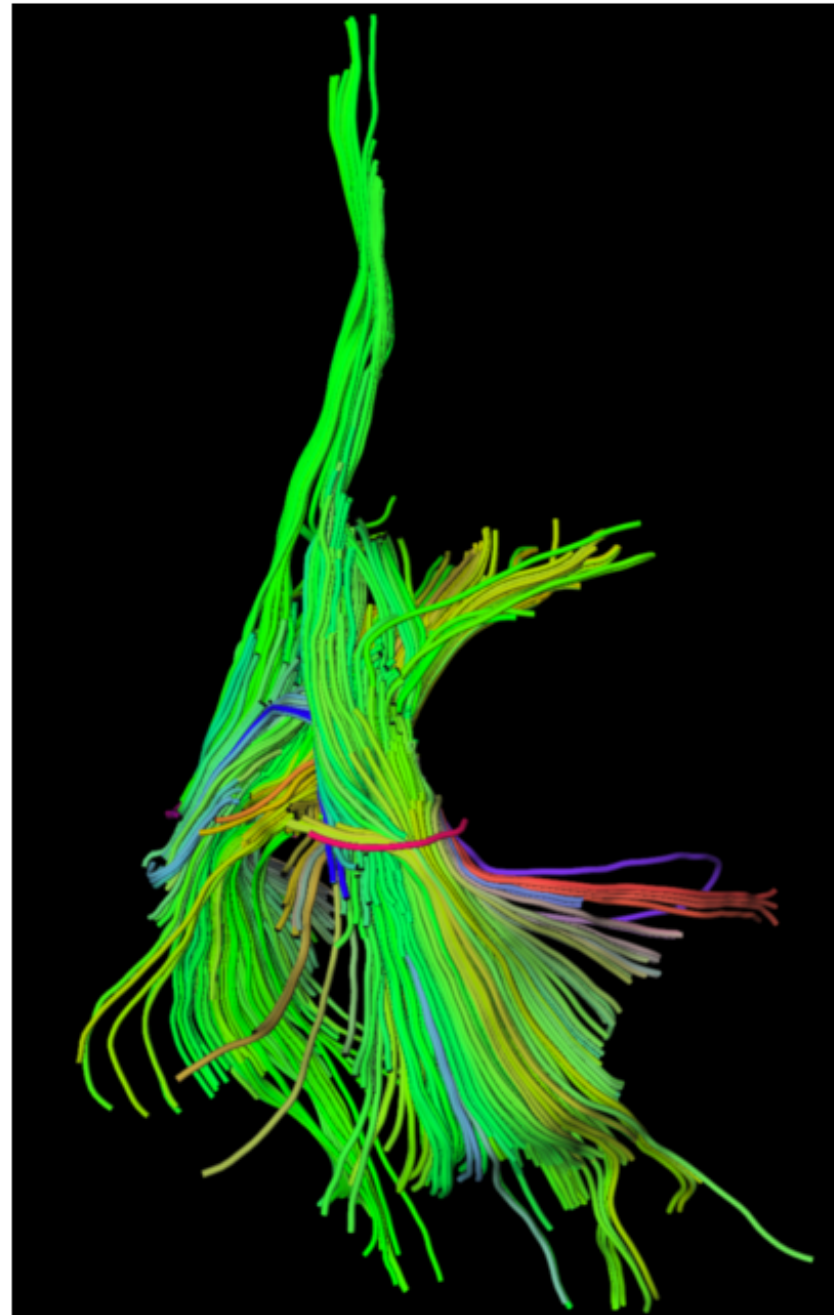
It is often useful to visualize a *line field*, a function that sends each point P of the plane or of space to a line through P (see Figure 2a, b):

show that no such mapping exists [9]: RP^2 is a nonorientable surface, it admits no embedding in 3-space.

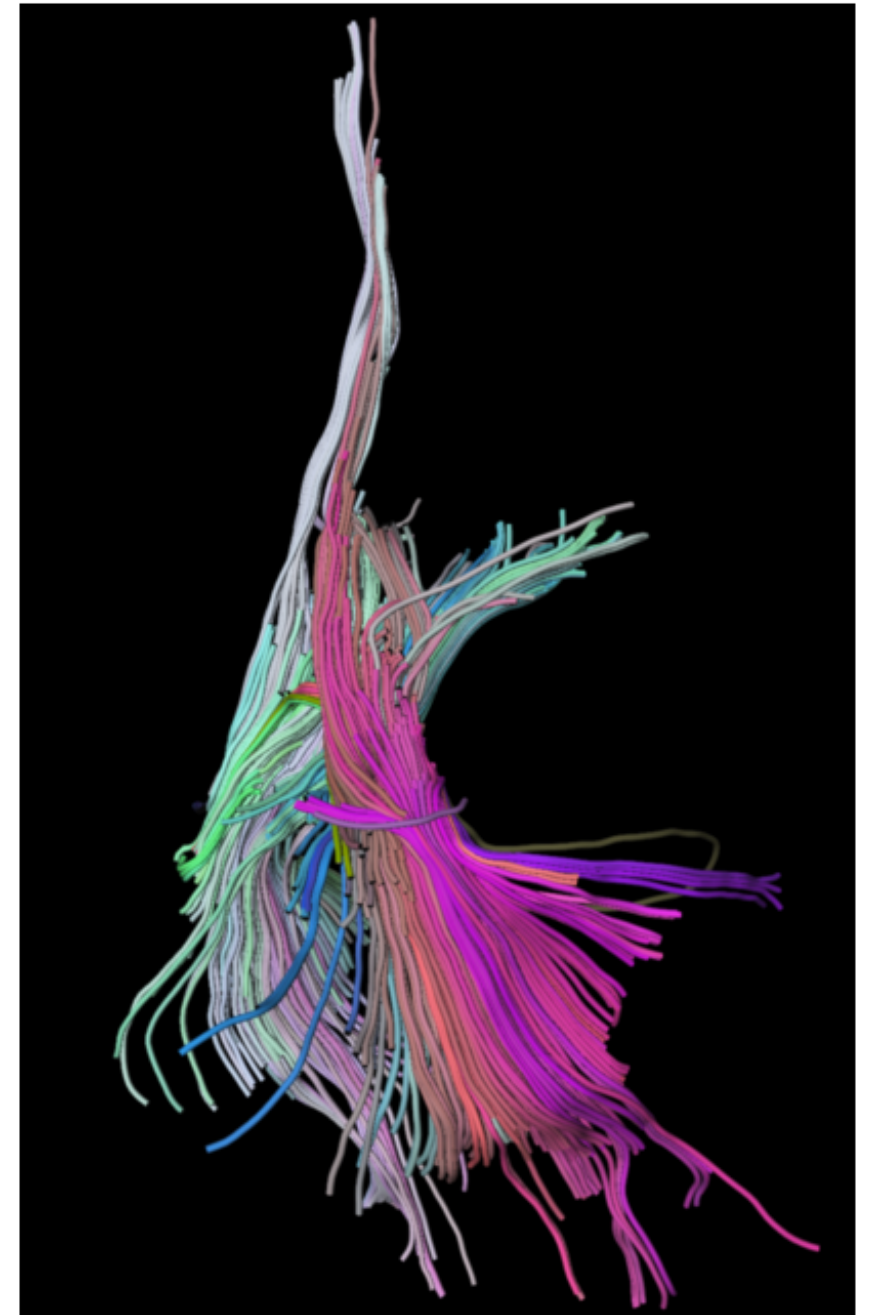
Orientation vs. Direction



(a)



(b)



(c)