Week 1: Intro, Marks and Channels

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JRNL 520M, Special Topics in Contemporary Journalism: Visualization for Journalists
Week 1: 15 September 2015

http://www.cs.ubc.ca/~tmm/courses/journ15

Who's who

- Instructor: Tamara Munzner
  - UBC Computer Science

- Journalistic kibitzer: Alfred Hermida
  - UBC Journalism

- Guest lecturer and significant labs help: Robert Kosara
  - Research Scientist, Tableau Software
  - previously UNC Charlotte Computer Science

Class time

- 6 weeks, Sep 15 - Oct 20
  - 1 3-hr session per week
- standard week
  - foundations lecture/discussion: 90 min
  - break: 15 min
  - demos: 30 min
  - lab: 45 min
- demo-intensive weeks
  - Week 1 & Week 4: longer demo from guest lecturer Robert Kosara
  - foundations 60 min, break 15 min, demos 60 min, lab 45 min

Structure

- participation
  - attendance and discussion in class, 16%
    - tell me in advance if you'll miss class (and why)
    - tell when you recover if you were ill
- homework, 84%
  - 6 assignments, 14% each
    - start in lab
    - finish over one week
    - due at start of next class session
  - some solo, some in groups of 2
    - gradual transition from structured to open-ended
    - final assignment: find your own interesting data and design your own visualization for it
- draft plan, may change as pilot continues!

Further reading

- optional textbook for following up on lecture topics
  - Tamara Munzner. Visualization Analysis and Design. CRC Press, 2014.
    - http://www.cs.ubc.ca/~tmm/vadbook/
  - library has multiple ebook copies
  - to buy yourself, see course page
- optional papers/books
  - links and references posted on course page
  - if DL links, use library EZproxy from off campus

Finding me

- email is the best way to reach me: tmm@cs.ubc.ca
- office hours by appointment
  - X661 (X-Wing of ICICS/CS bldg)

- course page is font of all information
  - don't forget to refresh, frequent updates
  - http://www.cs.ubc.ca/~tmm/courses/journ15

Topics

- Week 1
  - Intro
  - Marks and Channels
  - Demo: Tableau I, Kosara
- Week 2
  - Task and Data Abstractions
  - Arrange Tables
  - Demo: TBD
- Week 3
  - Color
  - Arrange Spatial Data
  - Demo: Text Tools & Resources, Brehmer
- Week 4
  - Arrange Networks
  - Demo: Tableau II, Kosara
- Week 5
  - Facet Into Multiple Views
  - Reduce Items and Attributes
  - Demo: TBD
- Week 6
  - Rules of Thumb
  - Putting It All Together
  - Demo: TBD

VAD Ch 1: What's Vis and Why Do It?

- Why have a human in the decision-making loop?
- Why have a computer in the loop?
- Why use an external representation?
- Why depend on vision?
- Why show the data in detail?
- Why is the vis idiom design space so huge?
- Why focus on tasks and effectiveness?
- Why are there resource limitations?
- Why analyze vis?

Defining visualization (vis)

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Why?...

Why have a human in the loop?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

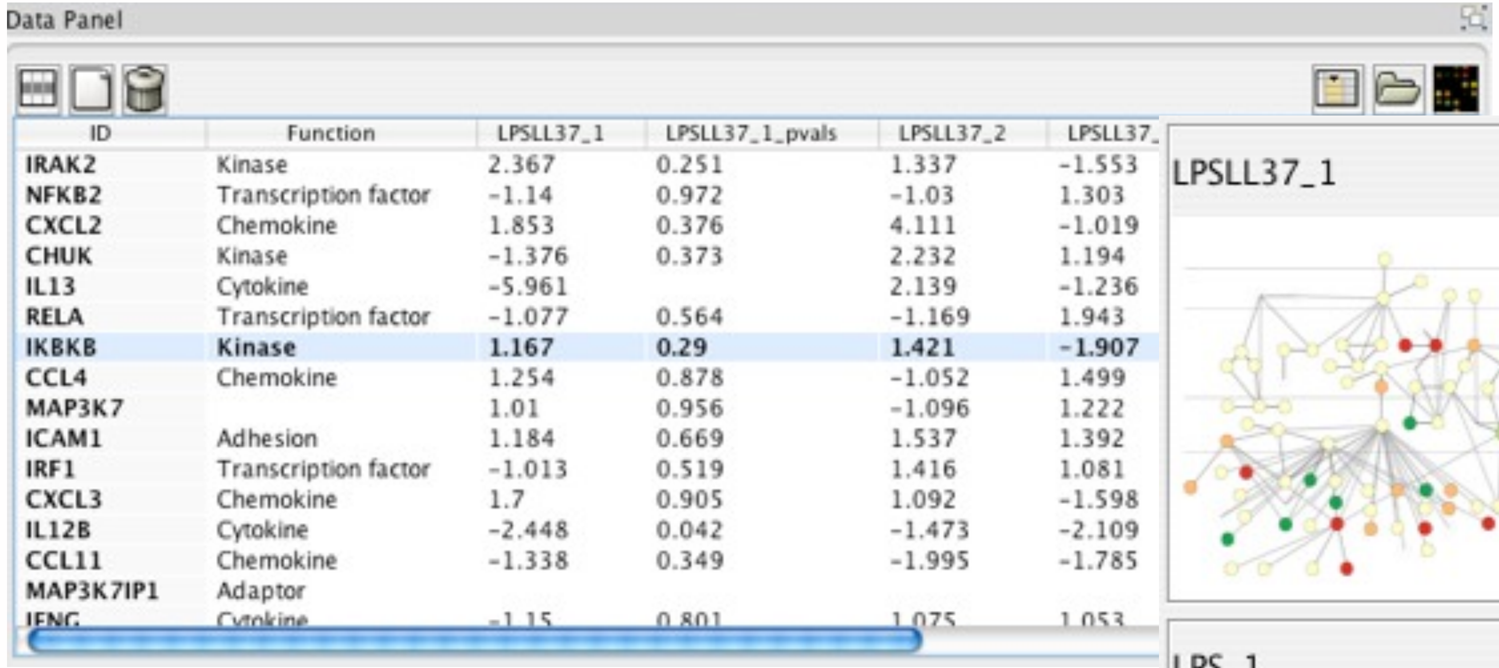
Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods.

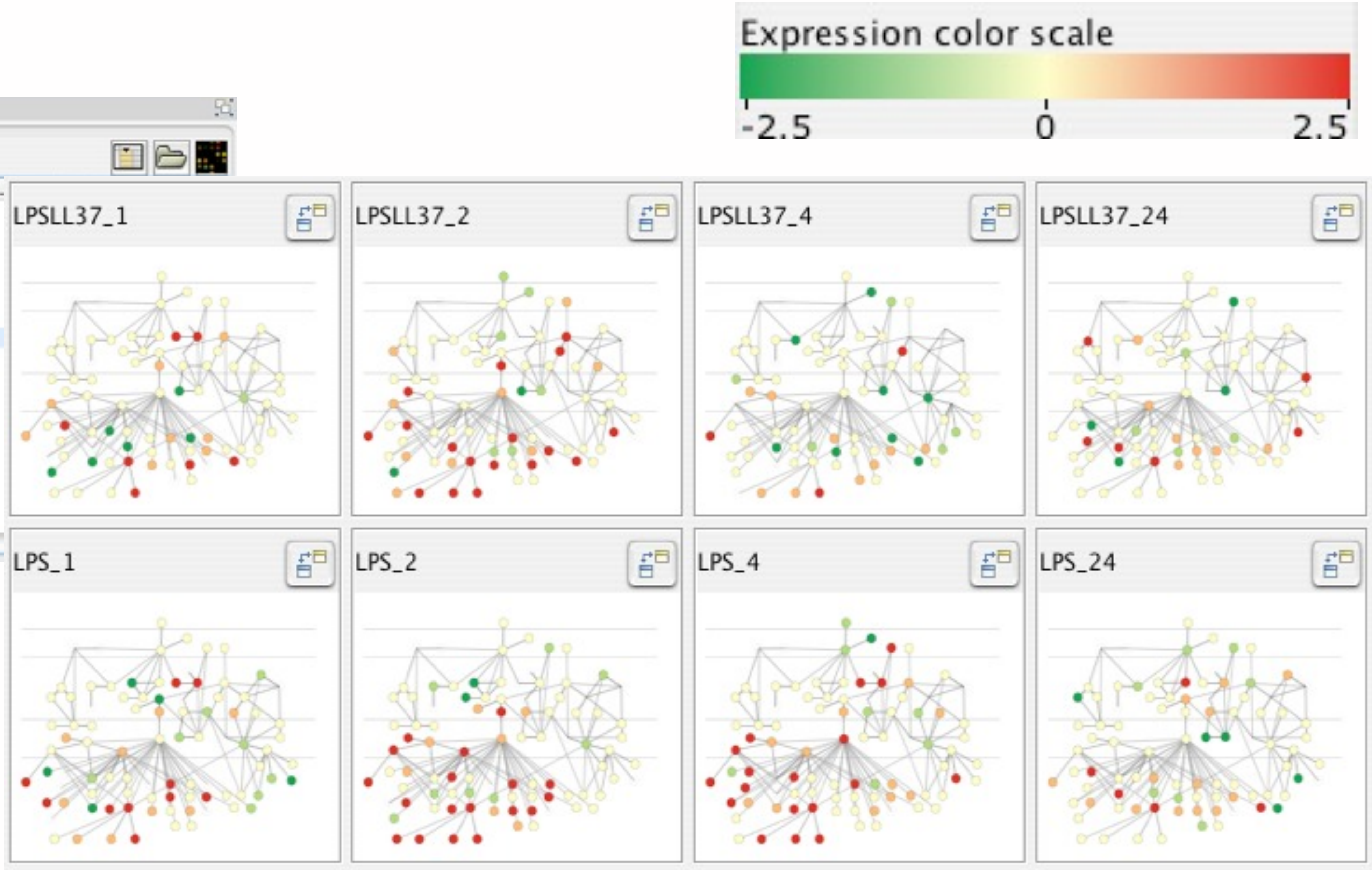
- don't need vis when fully automatic solution exists and is trusted
- many analysis problems ill-specified
  - don't know exactly what questions to ask in advance
- possibilities
  - long-term use for end users (e.g. exploratory analysis of scientific data)
  - *presentation of known results*
  - stepping stone to better understanding of requirements before developing models
  - help developers of automatic solution refine/debug, determine parameters
  - help end users of automatic solutions verify, build trust

Why use an external representation?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- external representation: replace cognition with perception



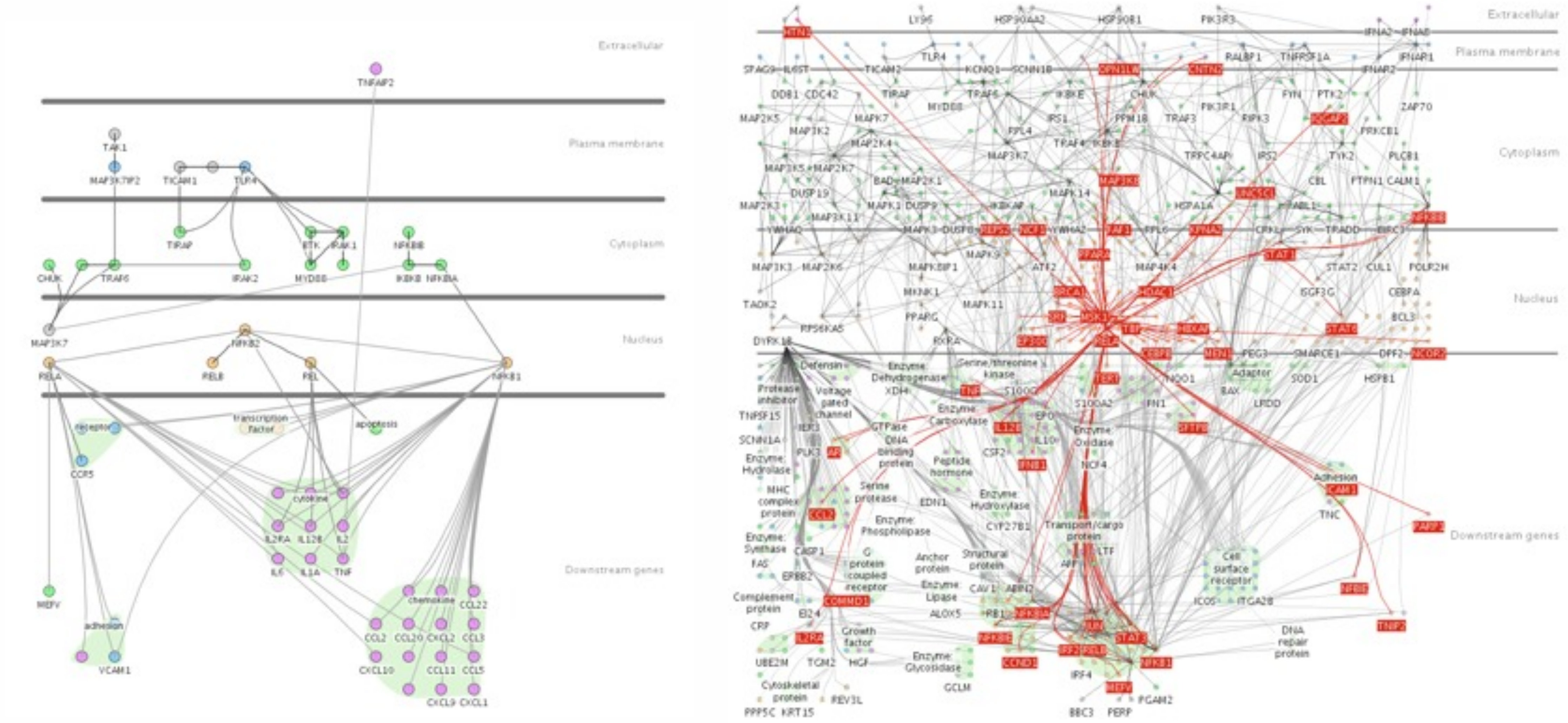


[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE TVCG (Proc. InfoVis) 14(6):1253-1260, 2008.]

Why have a computer in the loop?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- beyond human patience: scale to large datasets, support interactivity
  - consider: what aspects of hand-drawn diagrams are important?



[Cerebral: a Cytoscape plugin for layout of and interaction with biological networks using subcellular localization annotation. Barsky, Gardy, Hancock, and Munzner. Bioinformatics 23(8):1040-1042, 2007.]

Why depend on vision?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

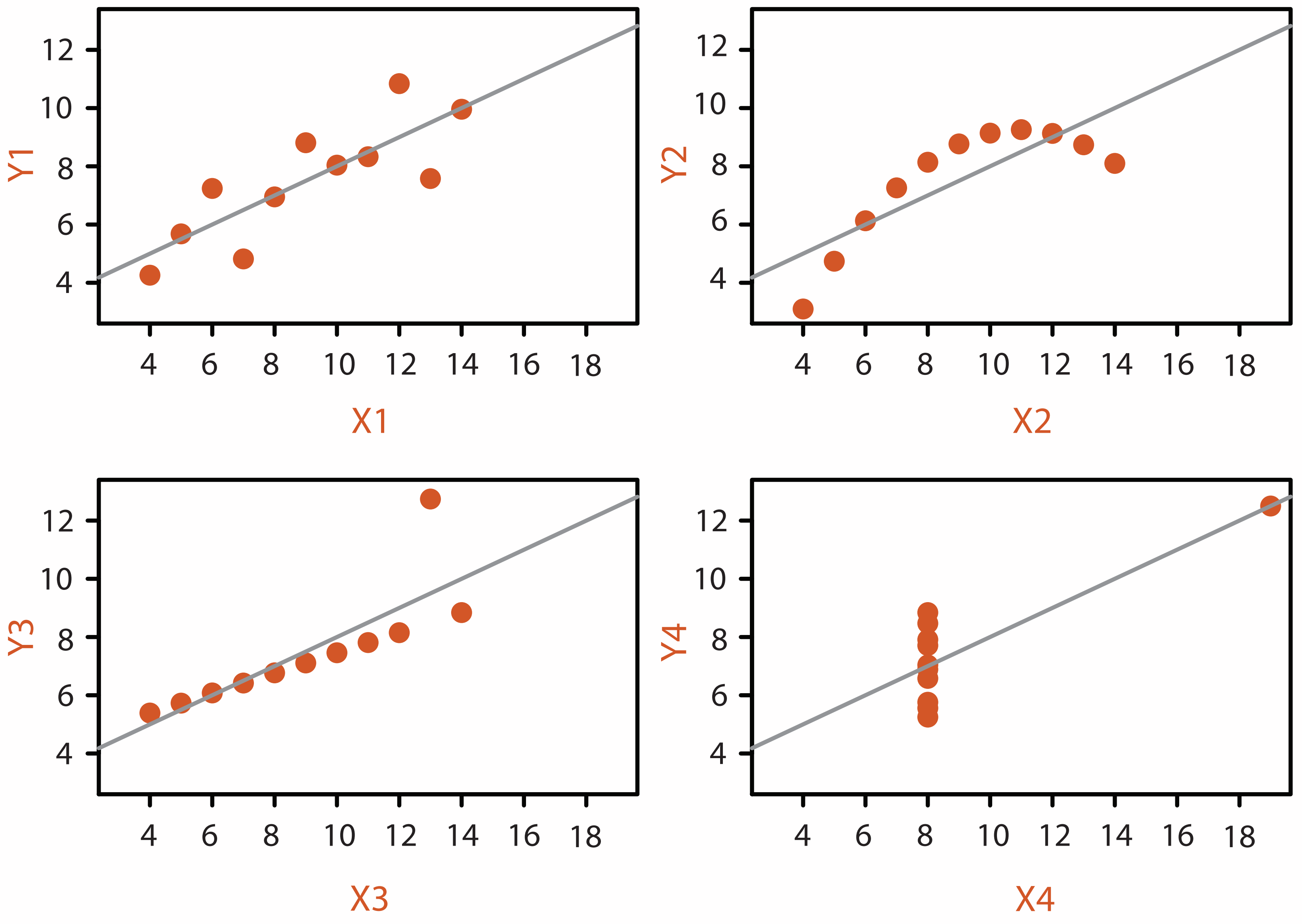
- human visual system is high-bandwidth channel to brain
  - overview possible due to background processing
    - subjective experience of seeing everything simultaneously
    - significant processing occurs in parallel and pre-attentively
- sound: lower bandwidth and different semantics
  - overview not supported
    - subjective experience of sequential stream
- touch/haptics: impoverished record/replay capacity
  - only very low-bandwidth communication thus far
- taste, smell: no viable record/replay devices

Why show the data in detail?

- summaries lose information
  - confirm expected and find unexpected patterns
  - assess validity of statistical model

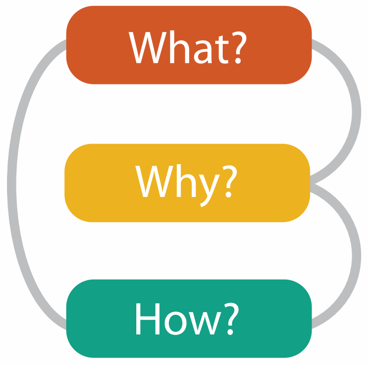
Anscombe's Quartet

Identical statistics	
x mean	9
x variance	10
y mean	8
y variance	4
x/y correlation	1



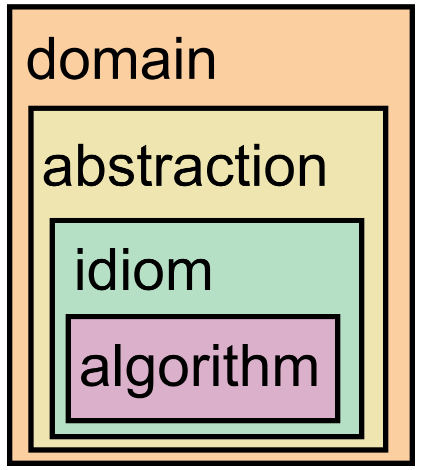
Why analyze?

- huge design space
  - visual encoding: combinatorial explosion of choices
  - add interaction: even bigger
  - add data abstraction transformation: truly enormous
- most possibilities ineffective for particular task/data combination
  - implication: avoid random walk, be guided by principles
- analysis framework: scaffold to think systematically about design space
  - ensure that consideration space encompasses full scope of possibilities
  - improve chances that selected solution is good not mediocre
  - next week's focus: abstractions and idioms, what-why-how

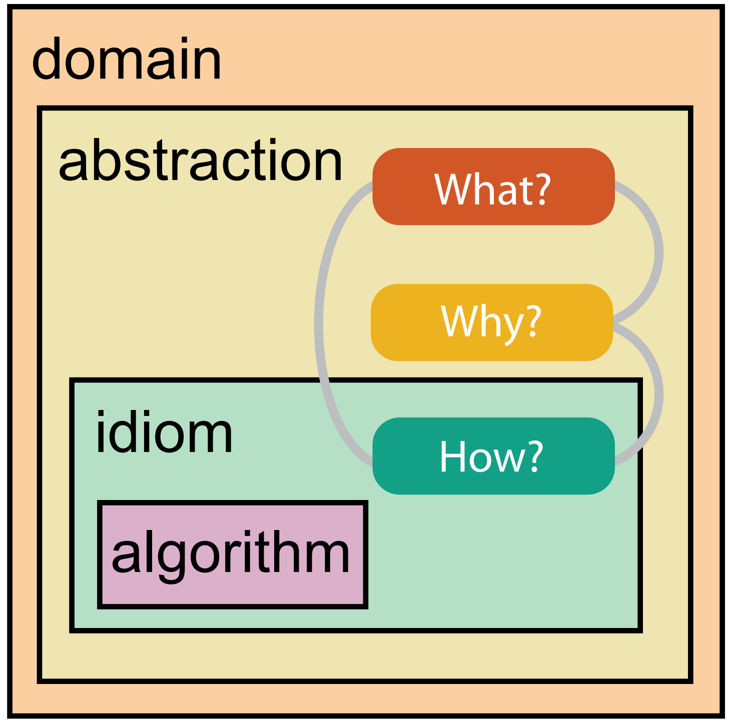


Analysis framework: Four levels, three questions

- *domain* situation
  – who are the target users?
- *abstraction*
  – translate from specifics of domain to vocabulary of vis
  - **what** is shown? **data abstraction**
  - **why** is the user looking at it? **task abstraction**
- *idiom*
  - **how** is it shown?
    - **visual encoding idiom**: how to draw
    - **interaction idiom**: how to manipulate
- *algorithm*
  – efficient computation



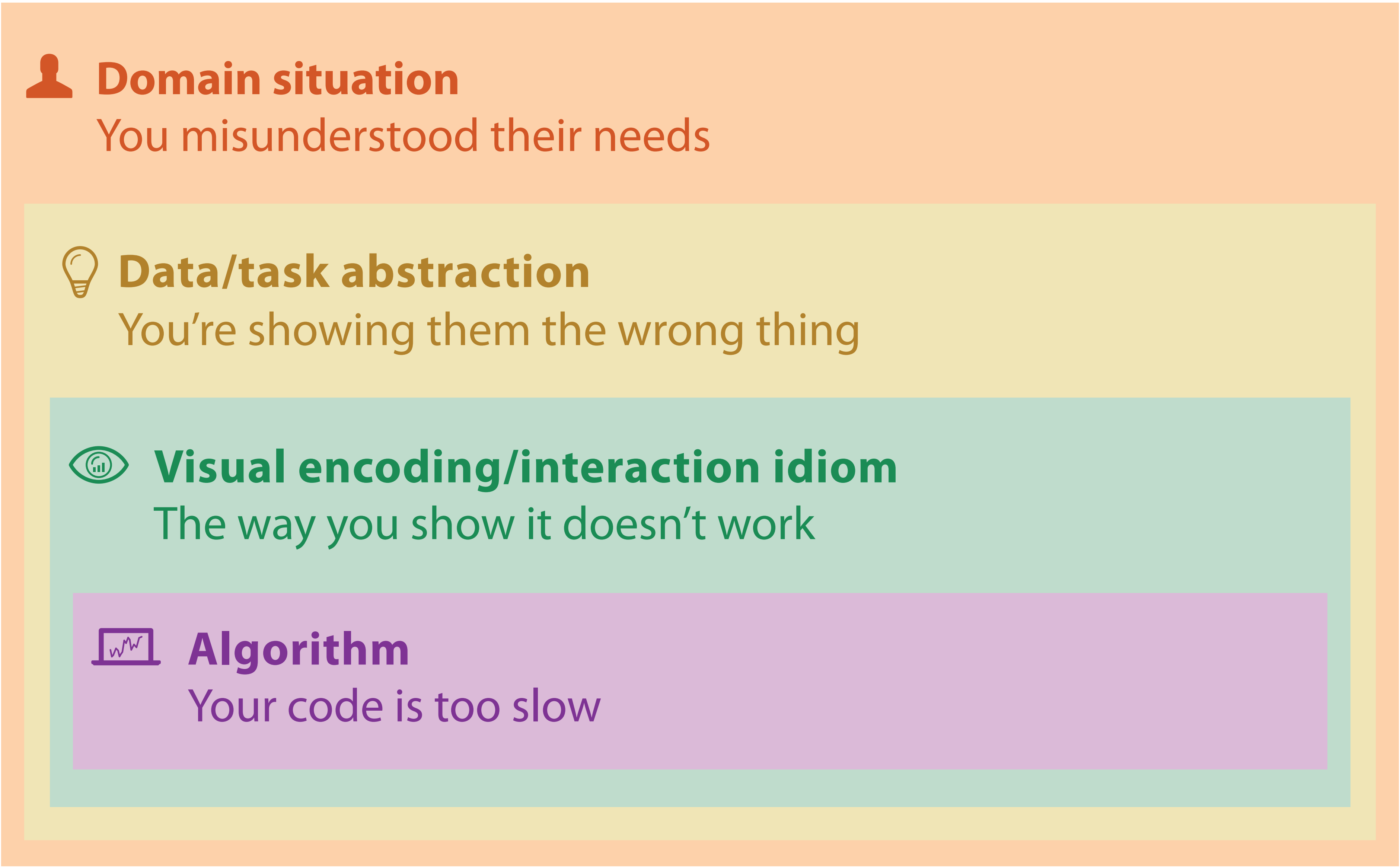
[A Nested Model of Visualization Design and Validation.
Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).]



[A Multi-Level Typology of Abstract Visualization Tasks
Brehmer and Munzner. IEEE TVCG 19(12):2376-2385, 2013 (Proc. InfoVis 2013).]

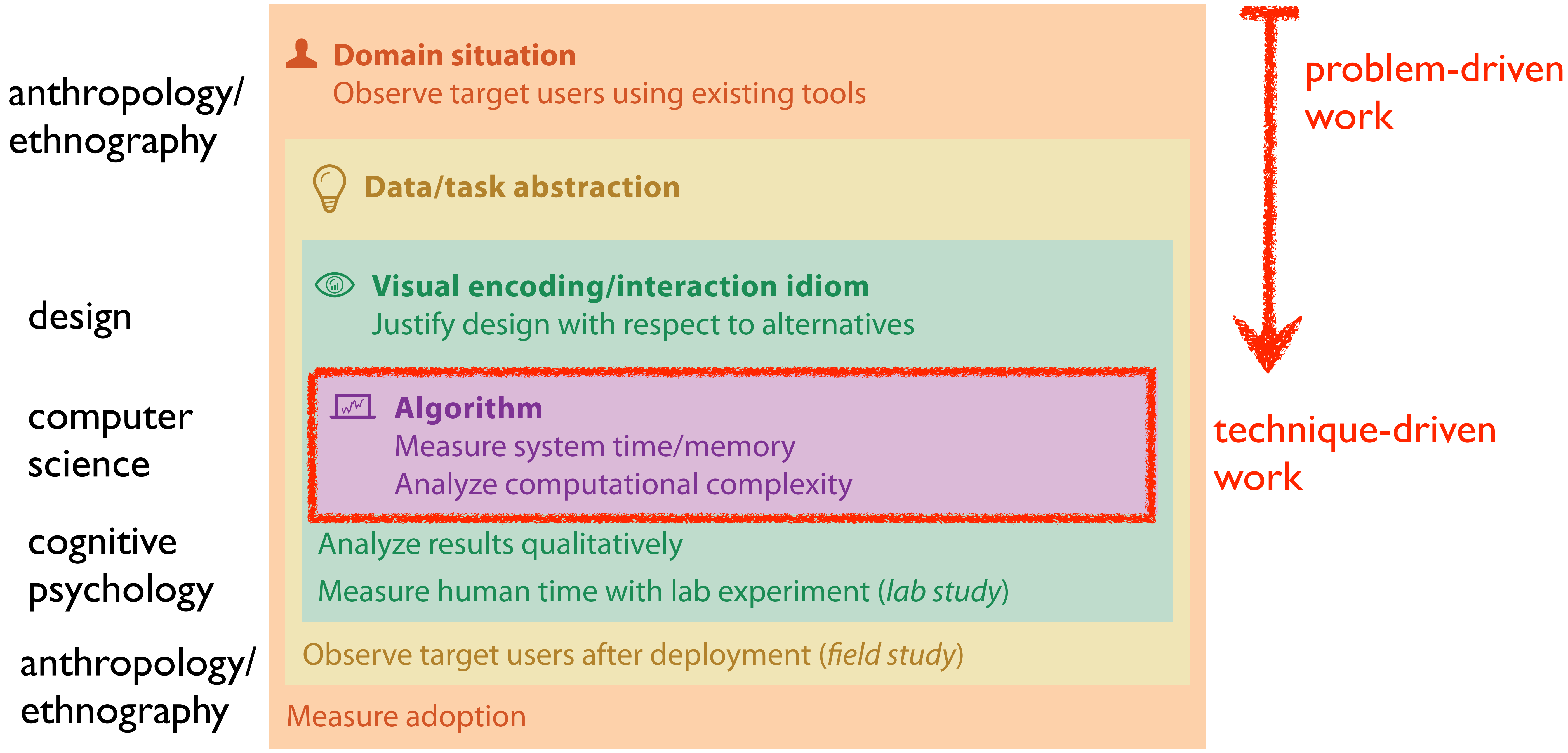
Why is validation difficult?

- different ways to get it wrong at each level



Why is validation difficult?

- solution: use methods from different fields at each level



[A Nested Model of Visualization Design and Validation. Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).]

Why focus on tasks and effectiveness?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

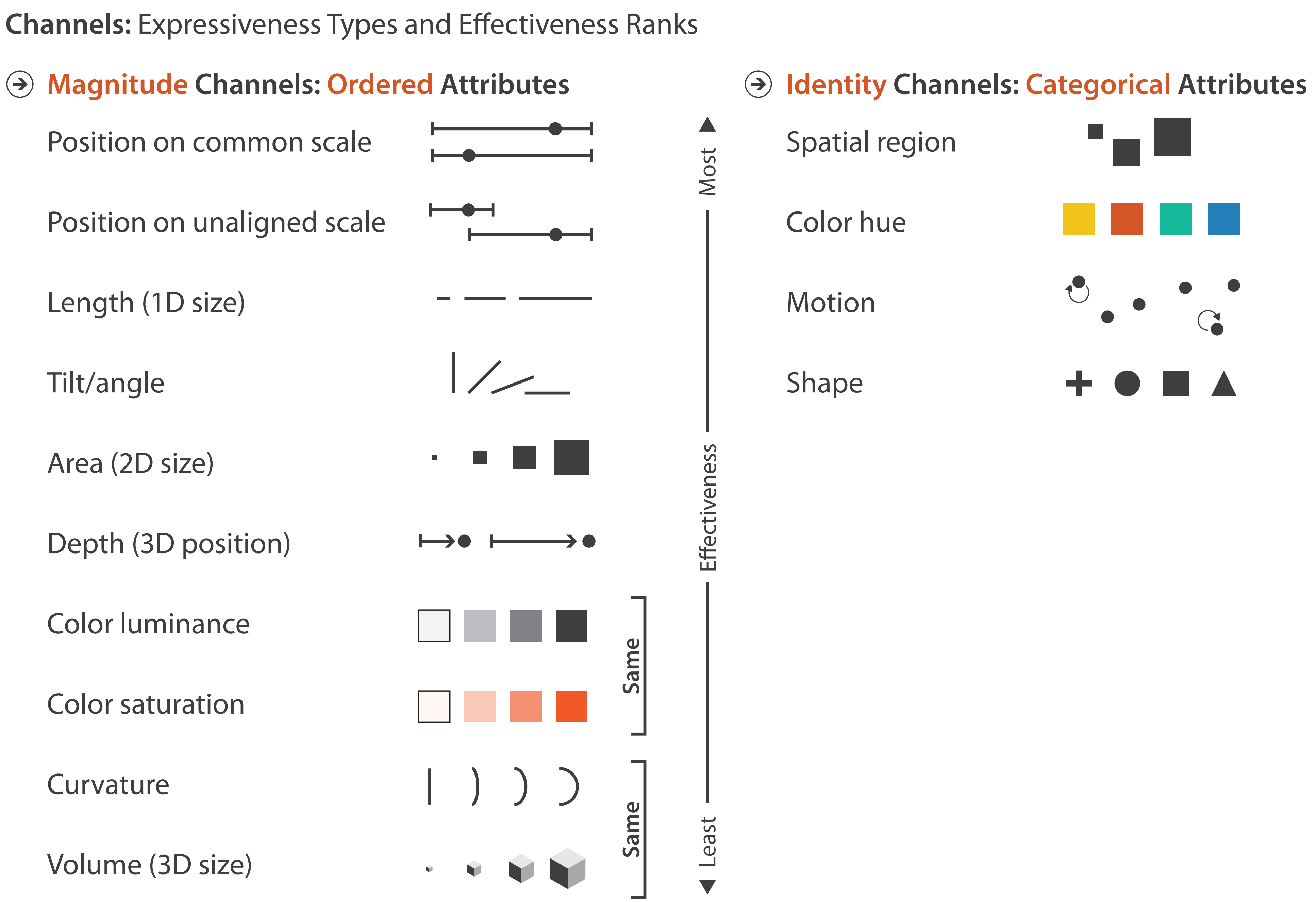
- tasks serve as constraint on design (as does data)
  - idioms do not serve all tasks equally!
  - challenge: recast tasks from domain-specific vocabulary to abstract forms
- most possibilities ineffective
  - validation is necessary, but tricky
  - increases chance of finding good solutions if you understand full space of possibilities
- what counts as effective?
  - novel: enable entirely new kinds of analysis
  - faster: speed up existing workflows

Why are there resource limitations?

Vis designers must take into account three very different kinds of resource limitations: those of computers, of humans, and of displays.

- computational limits
  - processing time
  - system memory
- human limits
  - human attention and memory
- display limits
  - pixels are precious resource, the most constrained resource
  - **information density**: ratio of space used to encode info vs unused whitespace
    - tradeoff between clutter and wasting space, find sweet spot between dense and sparse

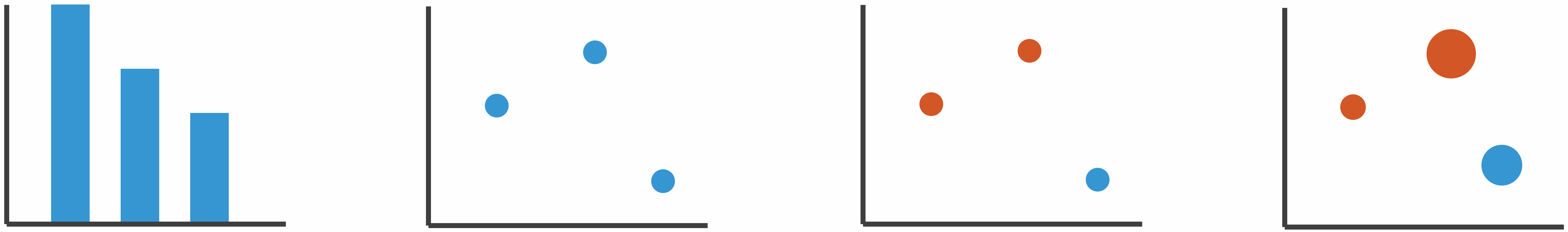
VAD Ch 5: Marks and Channels



[VAD Fig 5.1]

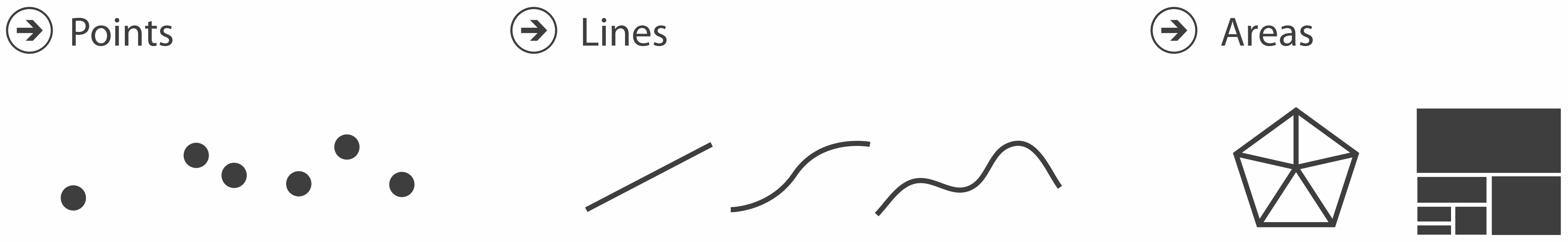
Encoding visually

- analyze idiom structure

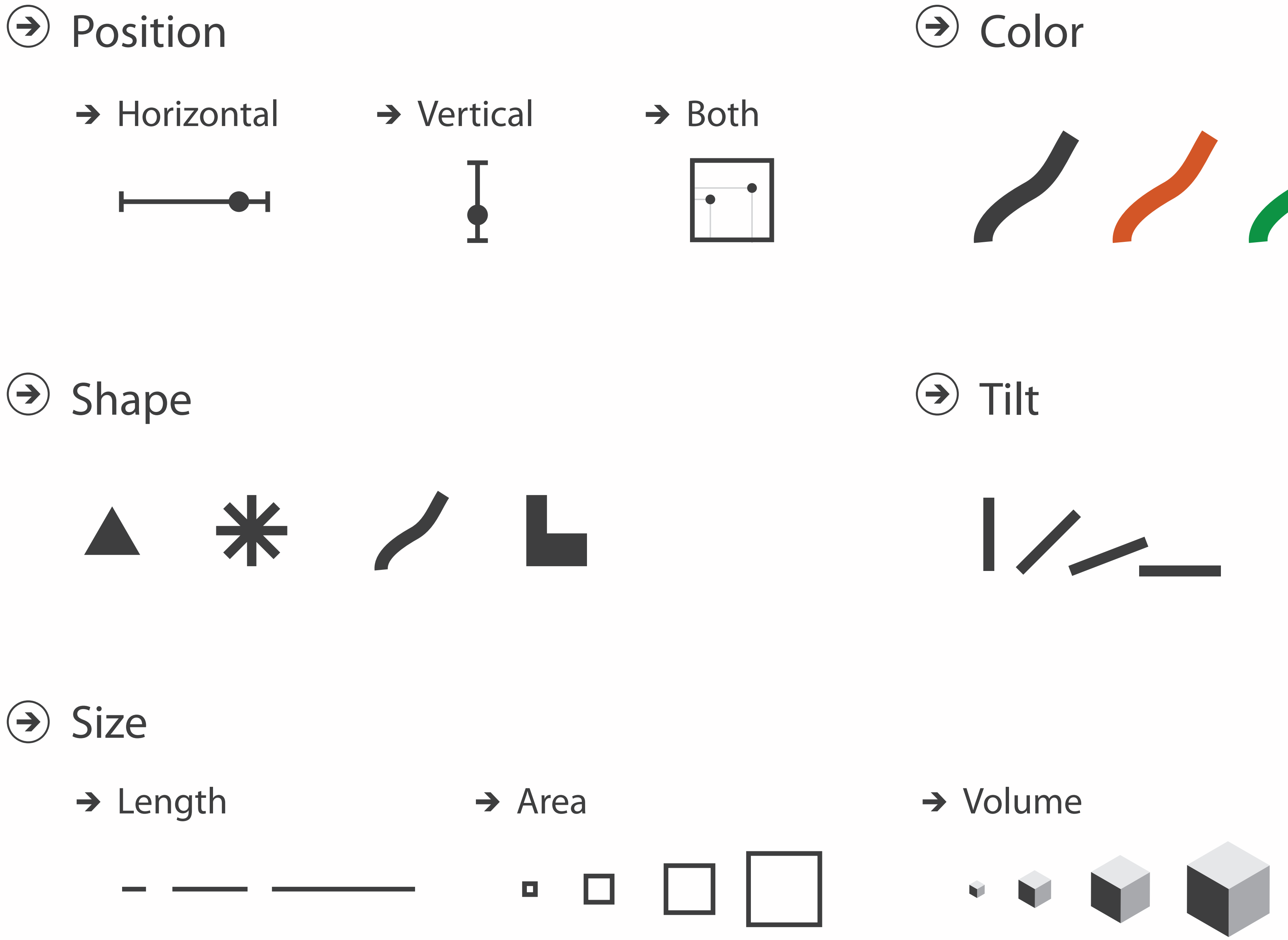


Definitions: Marks and channels

- marks
  - geometric primitives

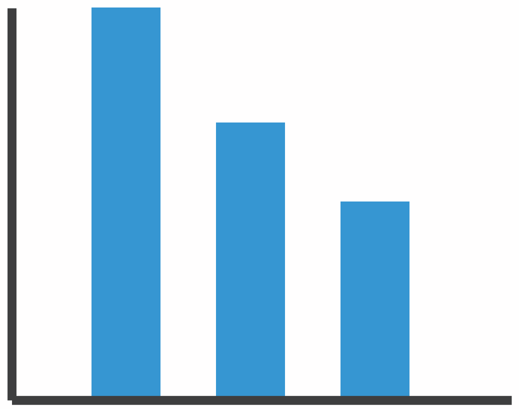


- channels
  - control appearance of marks



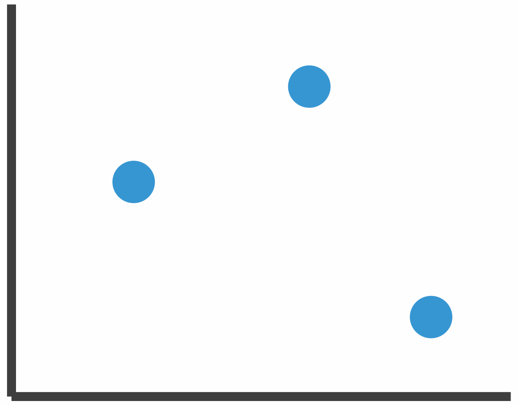
Encoding visually with marks and channels

- analyze idiom structure
  - as combination of marks and channels



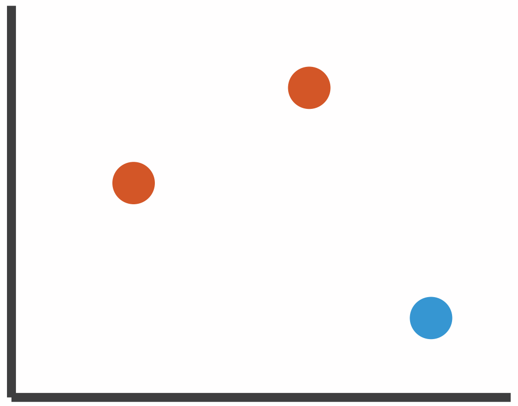
1:
vertical position

mark: line



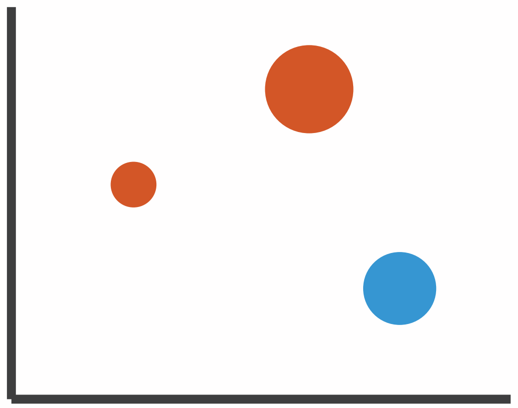
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

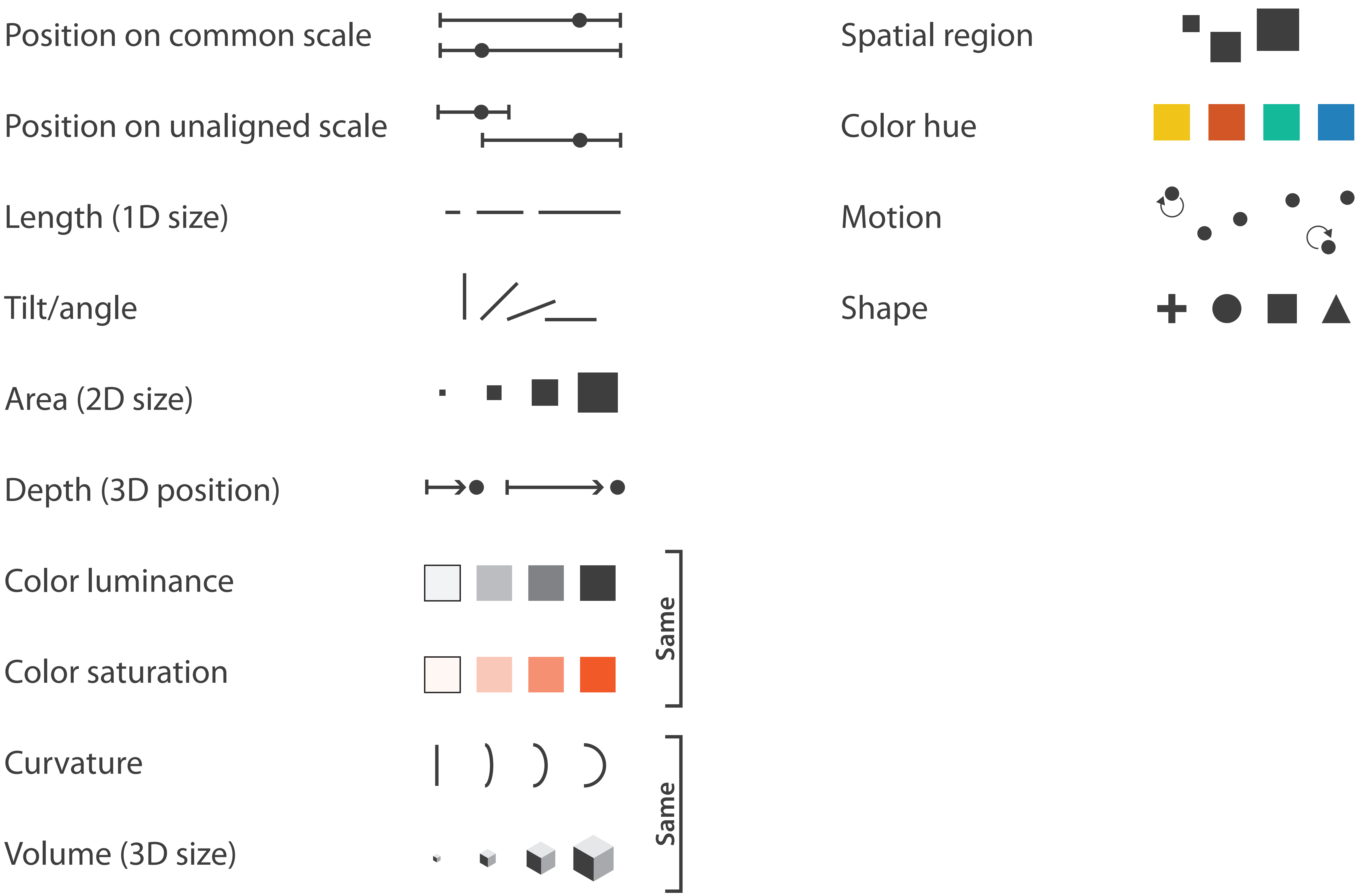
mark: point



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

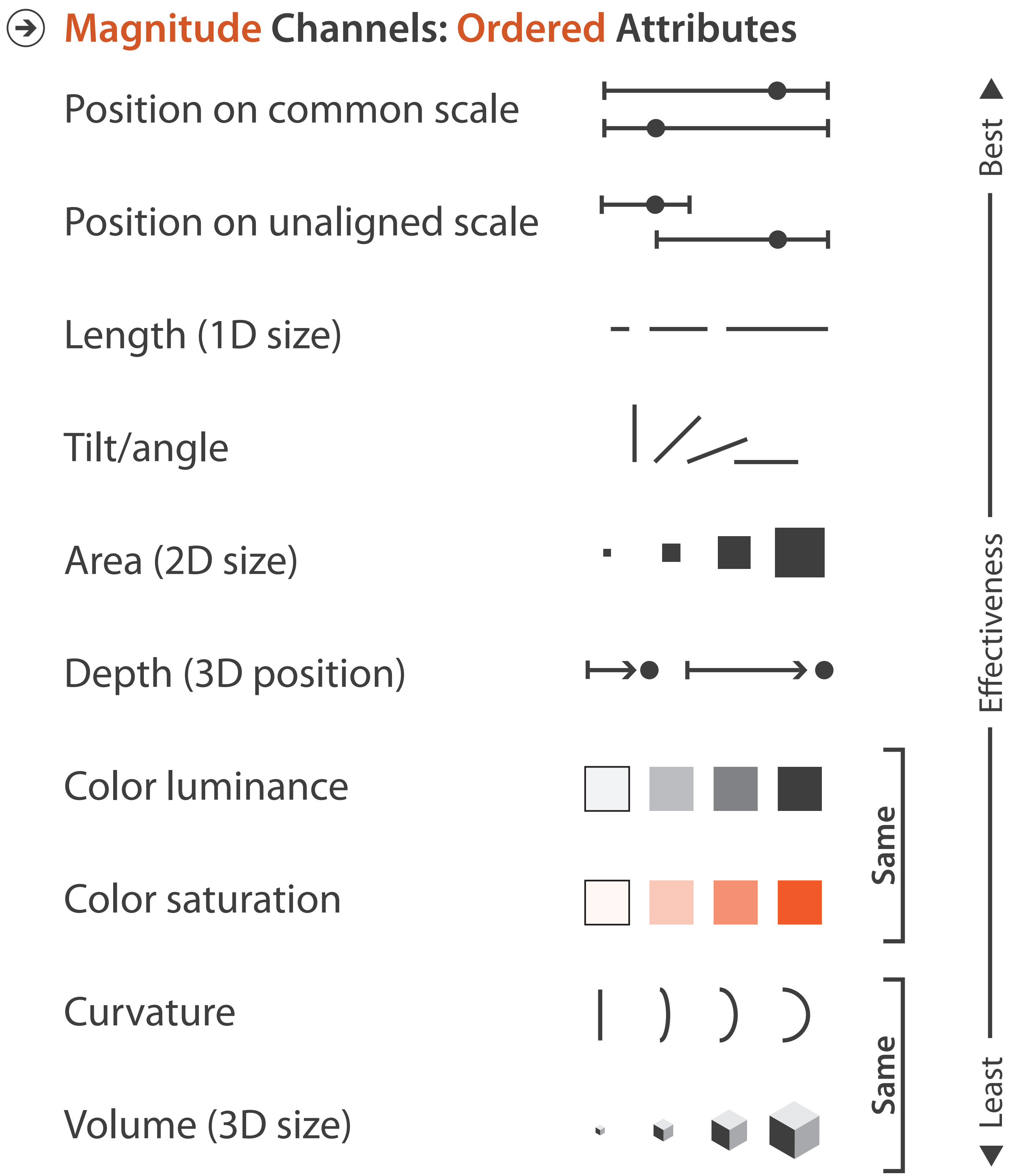
mark: point

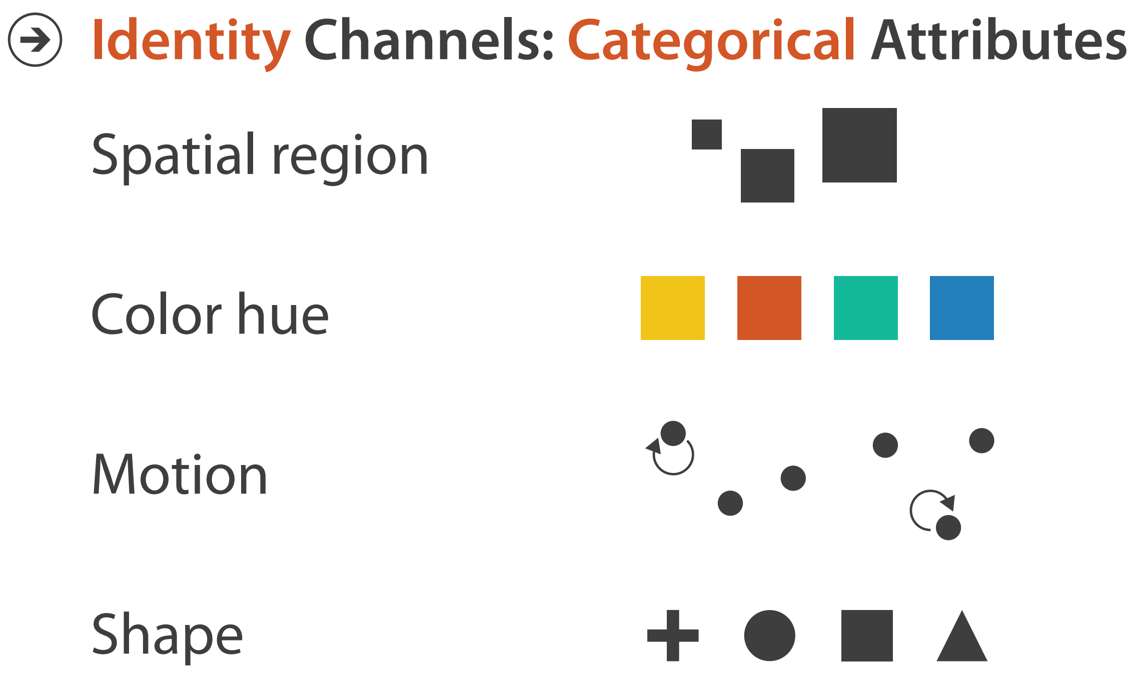
Channels



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

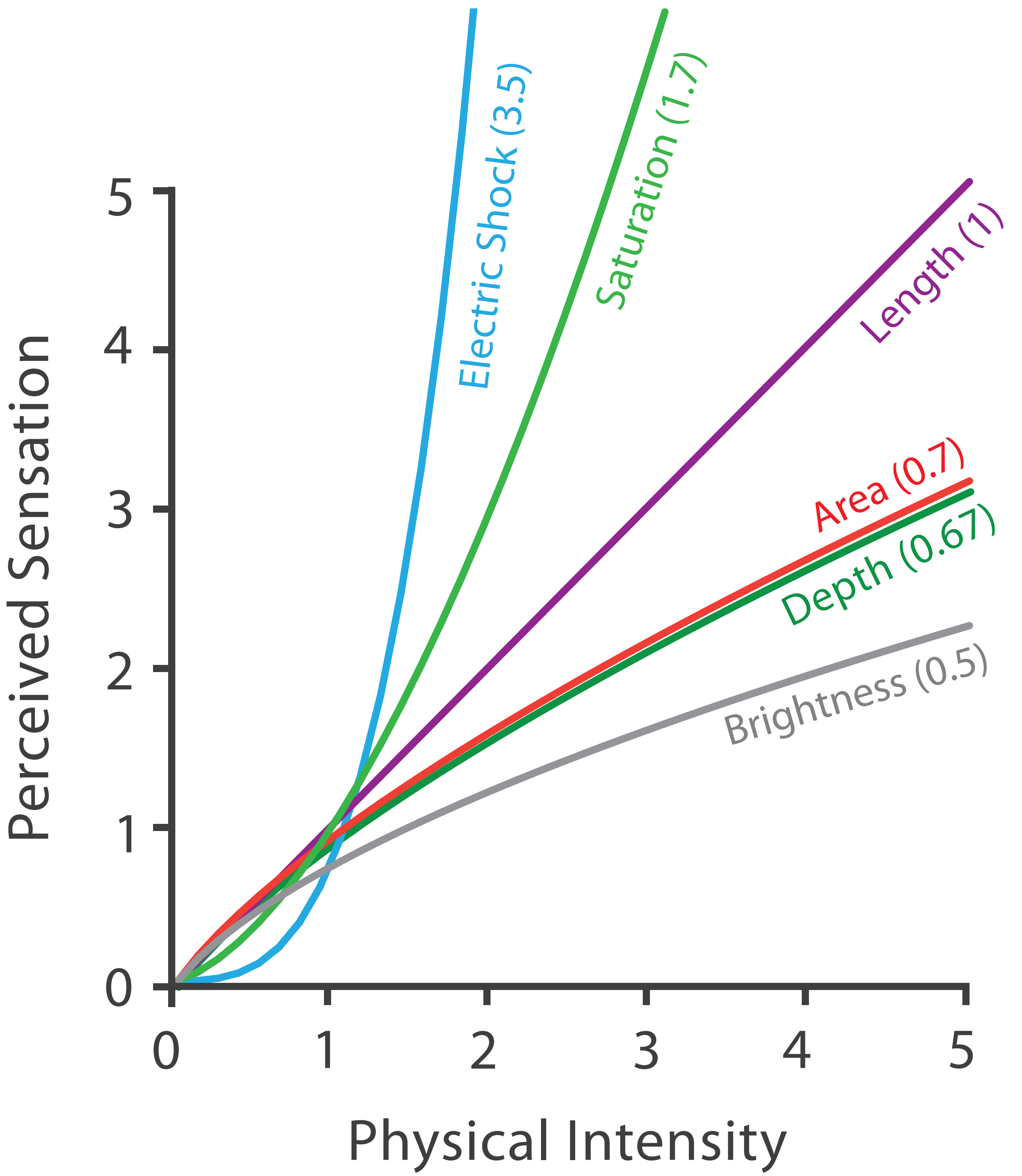




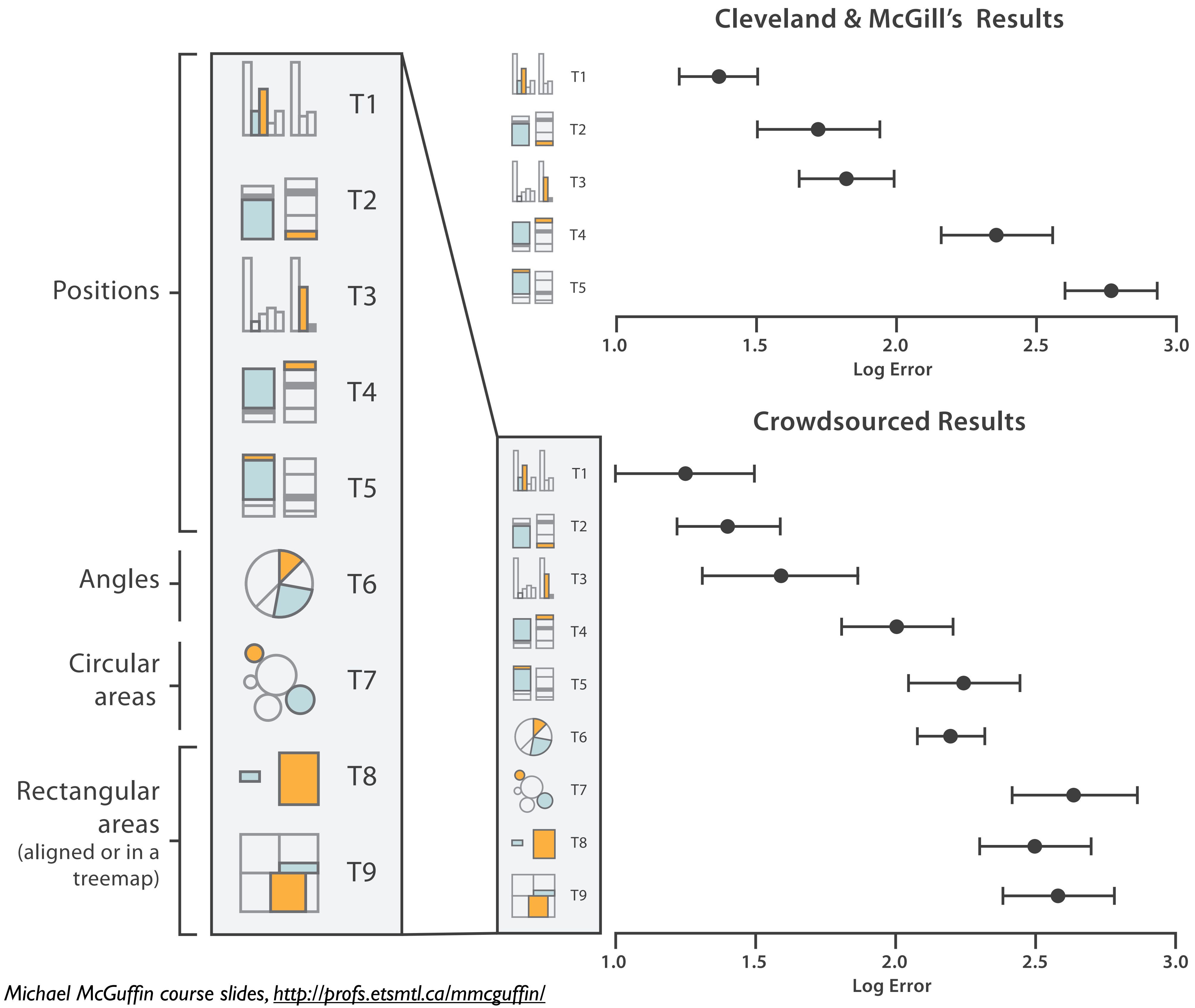
- effectiveness principle
  - encode most important attributes with highest ranked channels
- expressiveness principle
  - match channel and data characteristics

Accuracy: Fundamental Theory

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



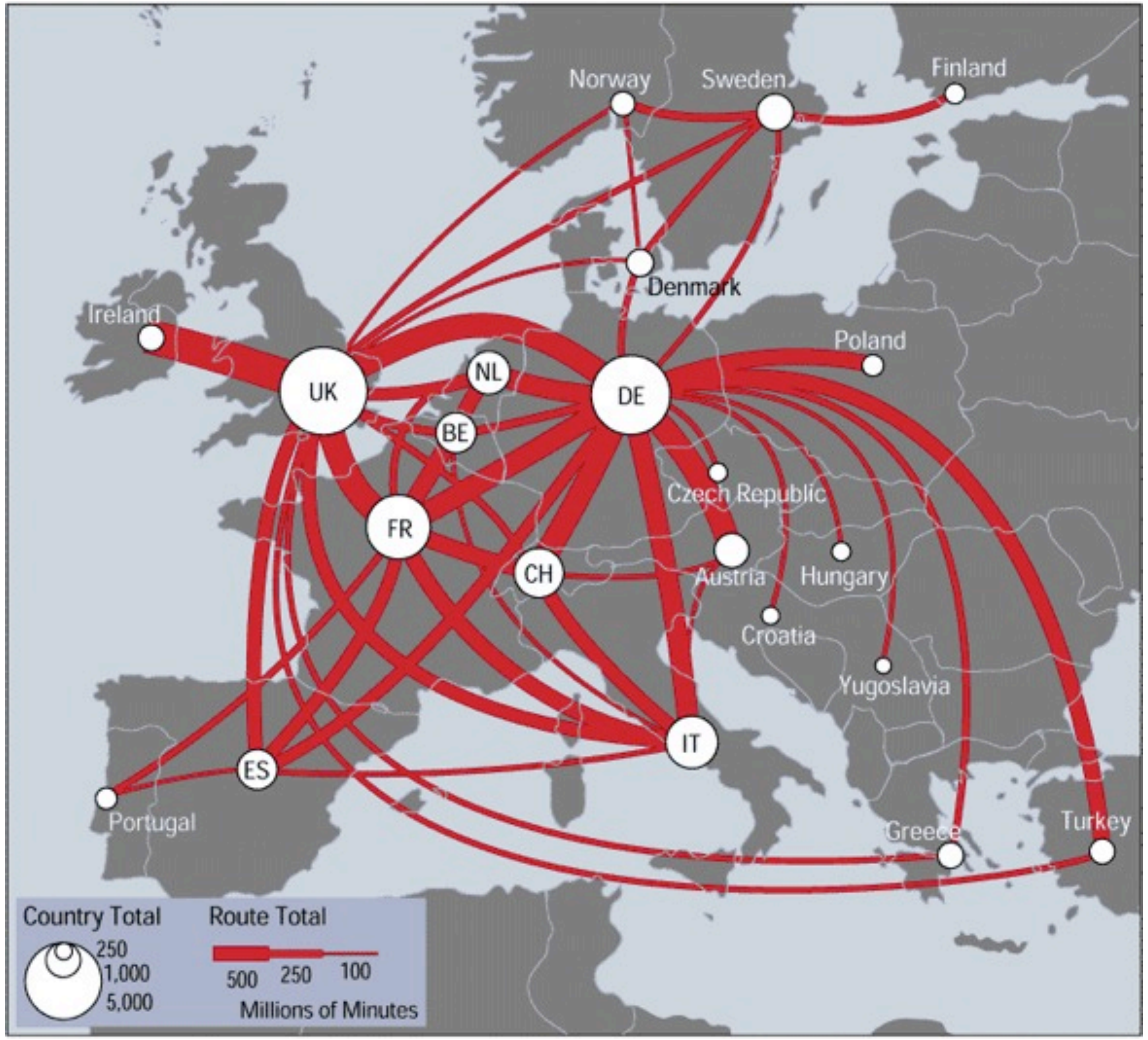
Accuracy: Vis experiments



[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?

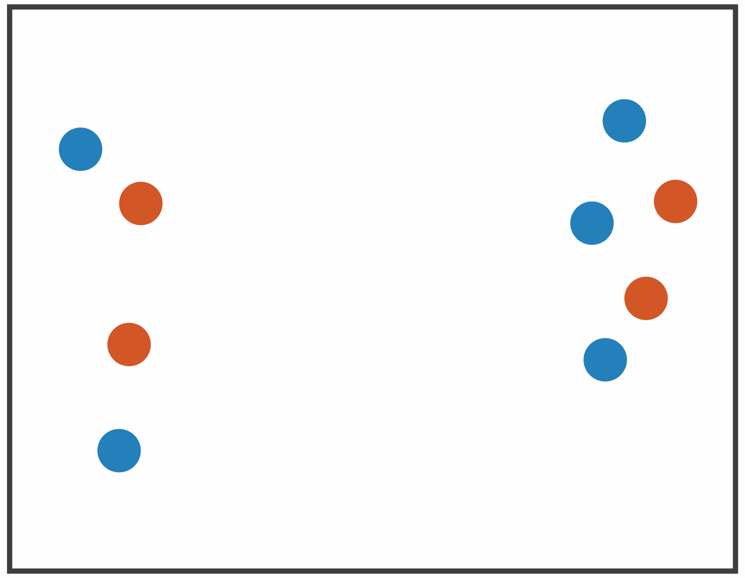
- must be sufficient for number of attribute levels to show
  - linewidth: few bins



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

Separability vs. Integrality

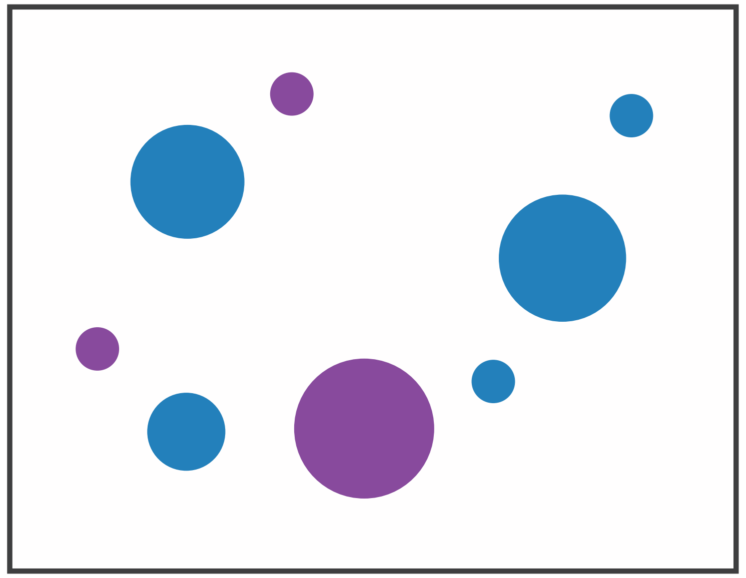
Position
+ Hue (Color)



Fully separable

2 groups each

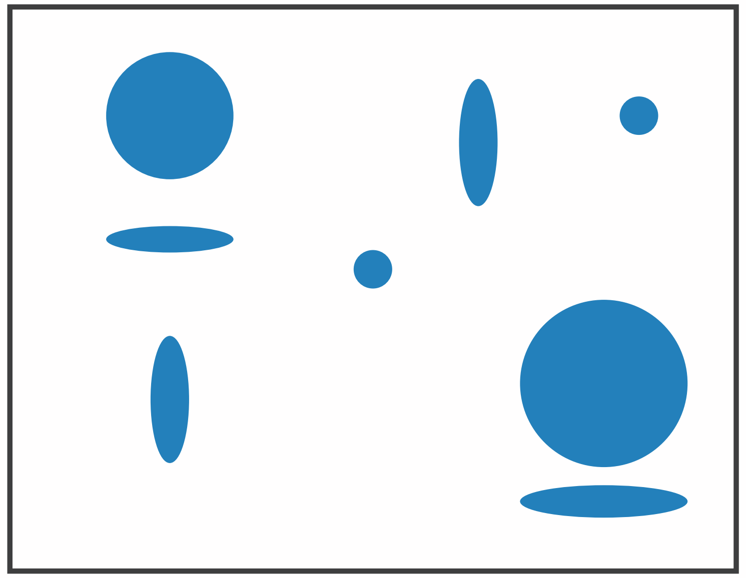
Size
+ Hue (Color)



Some interference

2 groups each

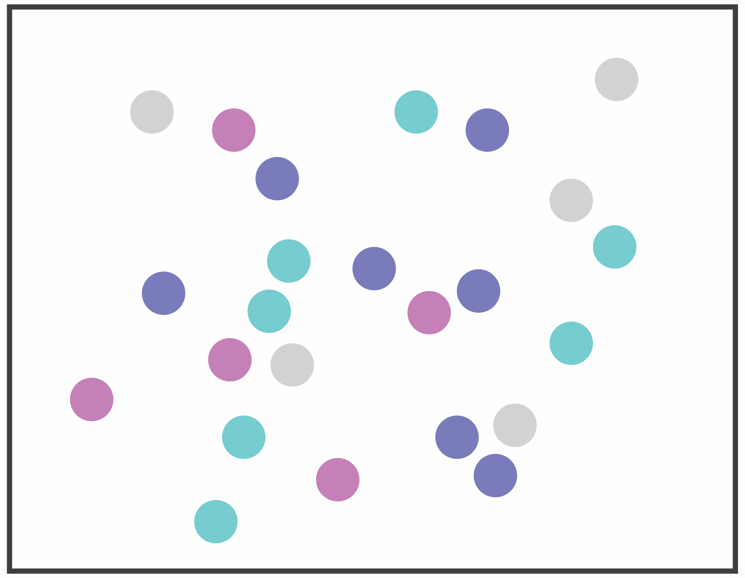
Width
+ Height



Some/significant interference

3 groups total: integral area

Red
+ Green

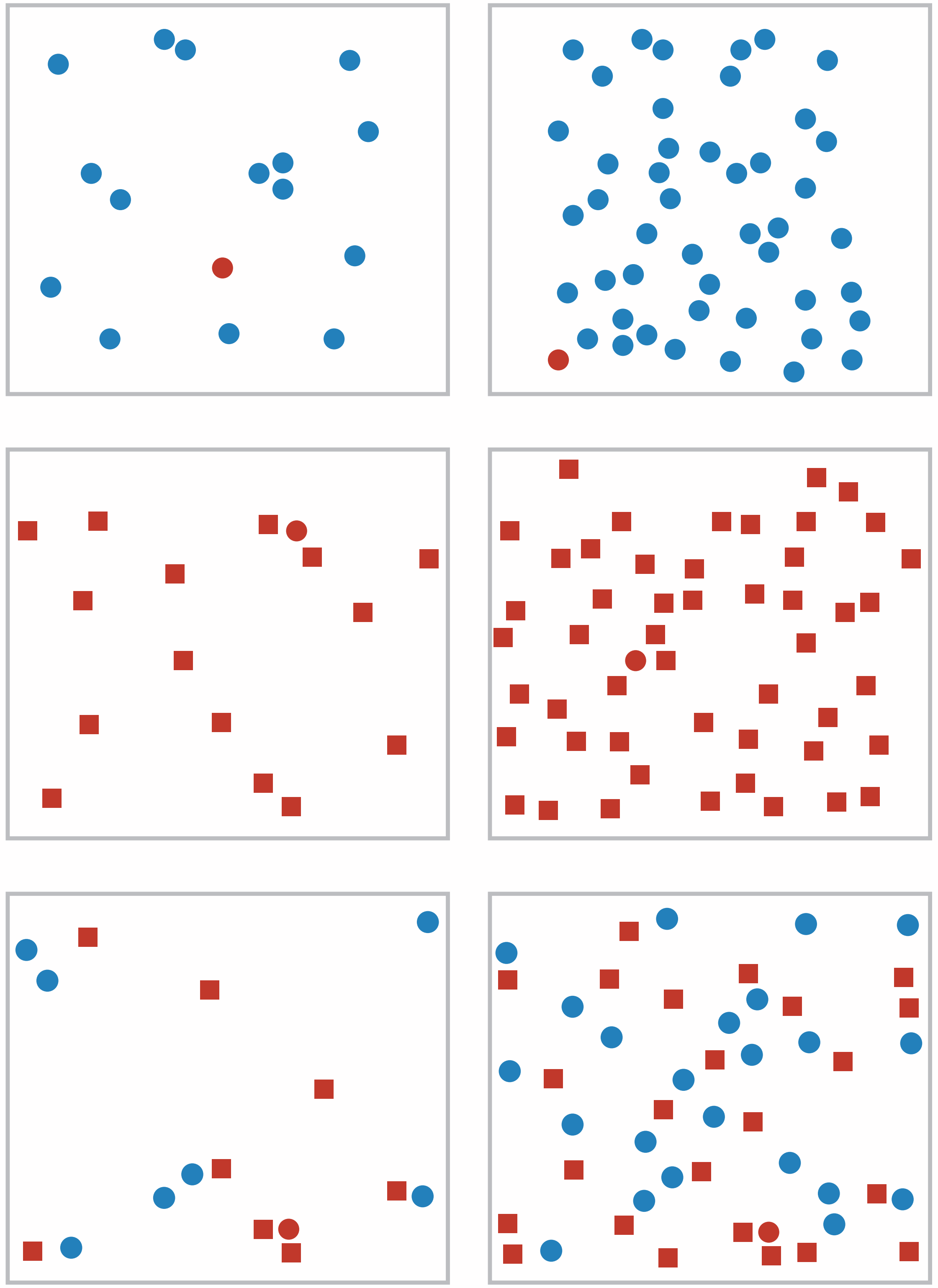


Major interference

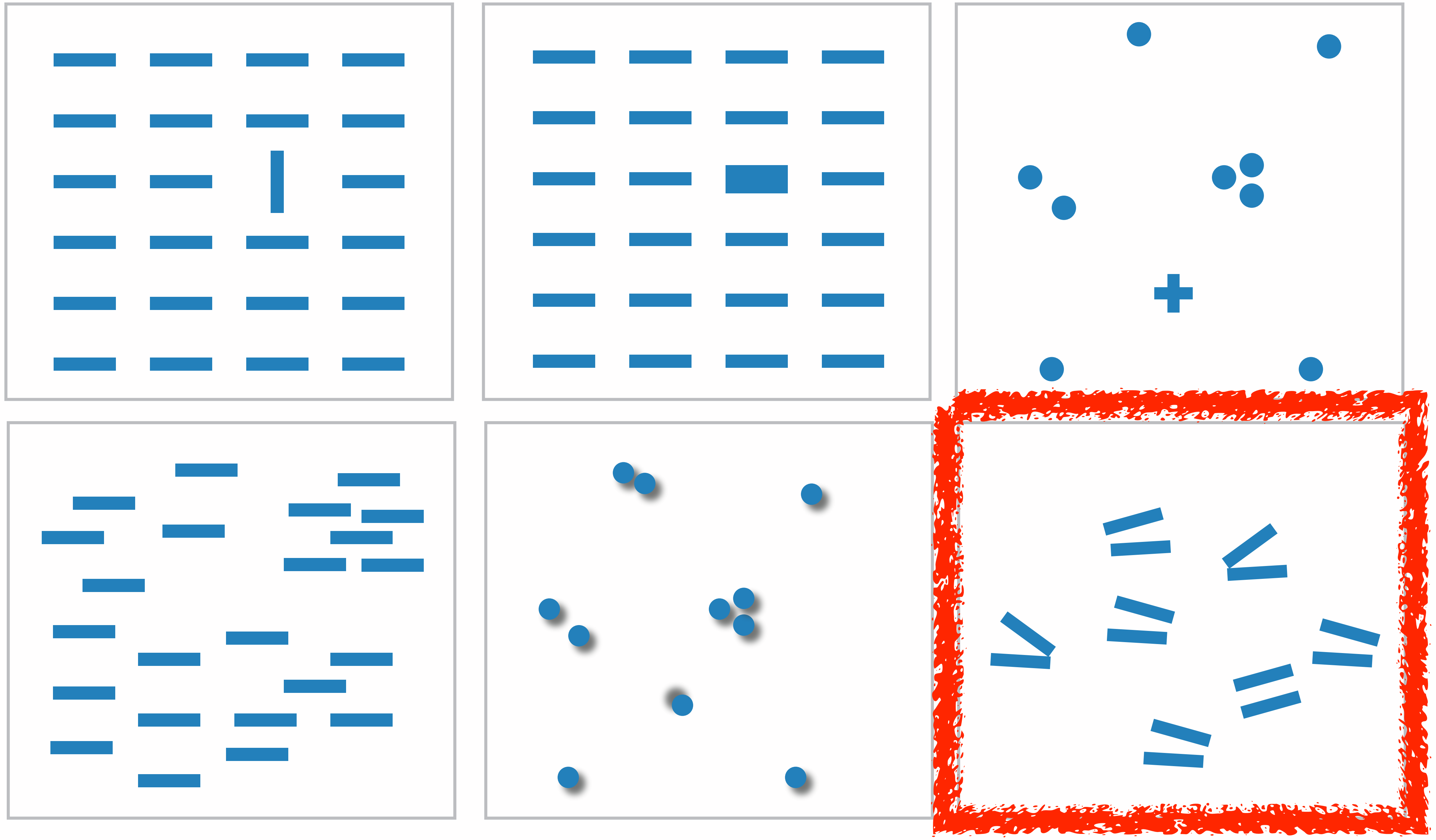
4 groups total: integral hue

Popout

- find the red dot
  - how long does it take?
- parallel processing on many individual channels
  - speed independent of distractor count
  - speed depends on channel and amount of difference from distractors
- serial search for (almost all) combinations
  - speed depends on number of distractors



Popout



- many channels: tilt, size, shape, proximity, shadow direction, ...
- but not all! parallel line pairs do not pop out from tilted pairs

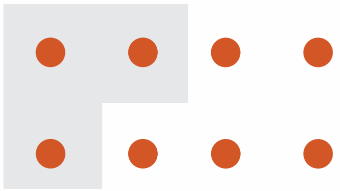
Grouping

- containment
- connection

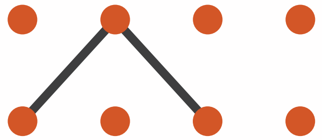
- proximity
  – same spatial region
- similarity
  – same values as other categorical channels

Marks as Links

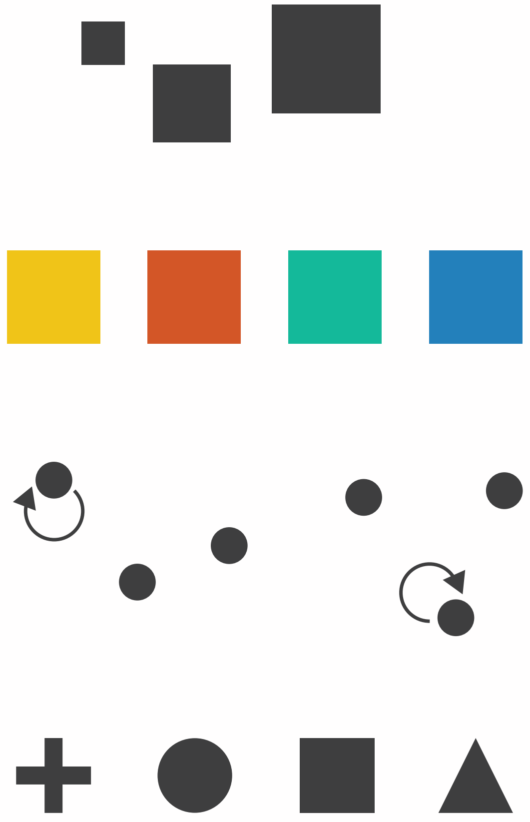
➔ Containment



➔ Connection

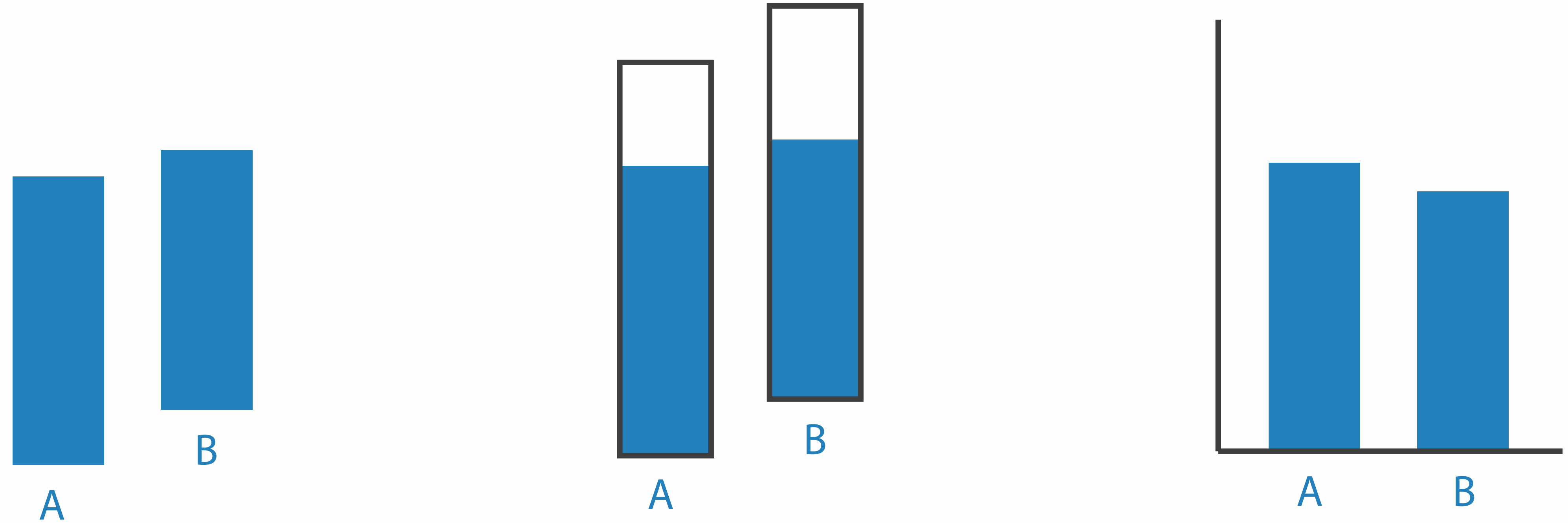


➔ Identity Channels: Categorical Attributes



Relative vs. absolute judgements

- perceptual system mostly operates with relative judgements, not absolute
  - that's why accuracy increases with common frame/scale and alignment
  - Weber's Law: ratio of increment to background is constant
    - filled rectangles differ in length by 1:9, difficult judgement
    - white rectangles differ in length by 1:2, easy judgement



length

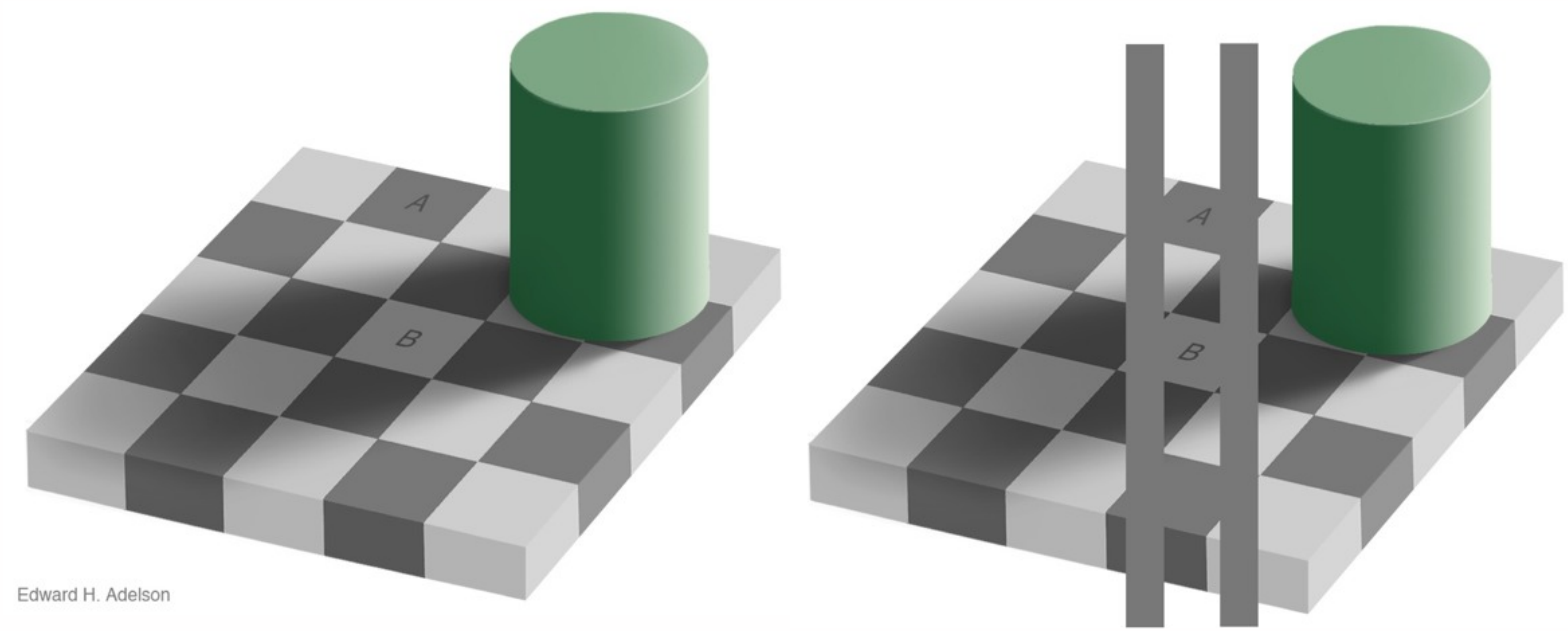
position along unaligned common scale

position along aligned scale

after [Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods. Cleveland and McGill. Journ. American Statistical Association 79:387 (1984), 531–554.]

Relative luminance judgements

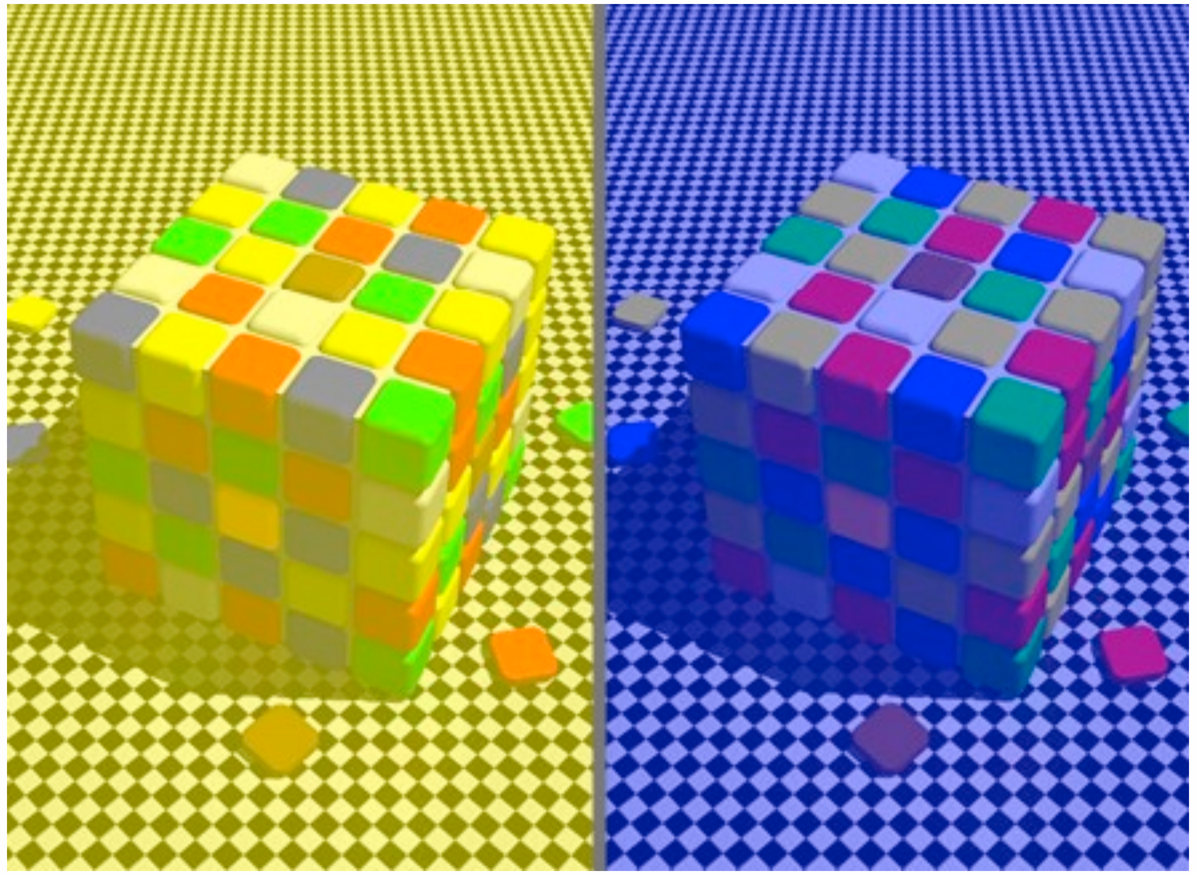
- perception of luminance is contextual based on contrast with surroundings

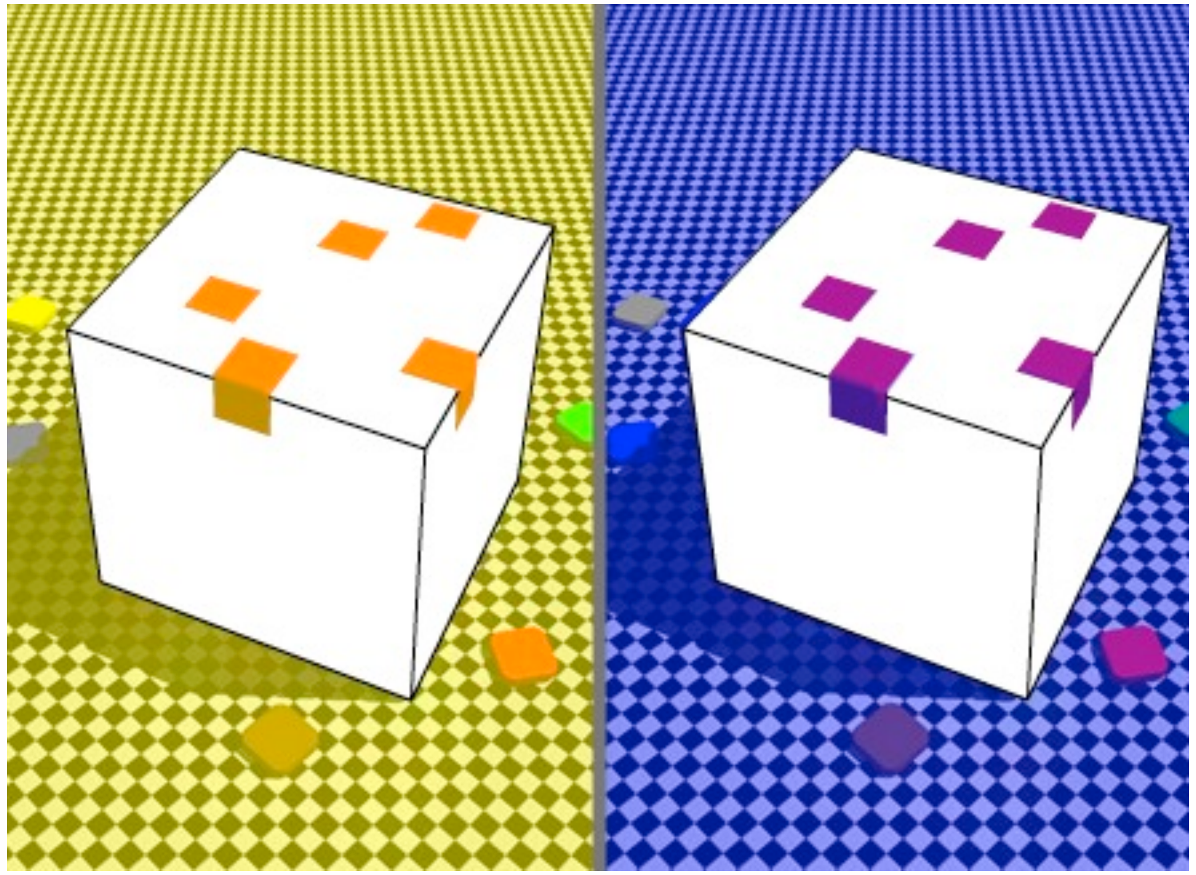


http://persci.mit.edu/gallery/checkershadow

Relative color judgements

- color constancy across broad range of illumination conditions





http://www.purveslab.net/seeforyourself/

Further reading

- Visualization Analysis and Design. Tamara Munzner. CRC Press, 2014.
  - *Chap 1: What's Vis, and Why Do It?*
  - *Chap 5: Marks and Channels*

- Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design. Jeffrey Heer and Michael Bostock. Proc. CHI 2010
- Perception in Vision web page with demos, Christopher Healey.
- Visual Thinking for Design. Colin Ware. Morgan Kaufmann, 2008.

Now

- Break (15 min)
- Demo: Guest lecture/demo from Robert Kosara on Tableau
- Lab: you'll try it!

Lab/Assignment (Updated after class)

- install Tableau on your own laptop
  - using course key from me or individual license key that you request personally
- work through Vienna tutorial (data: Chicago crime 2015, US forest fires)
- work through intro tutorial (data: music sales)
- download 1033 dataset from Tableau Public
  - play with it based on what you learned from Robert's demo
- pick three datasets from Tableau public
  - visualize them with Tableau with what you learned from demo and tutorials, also try at least two new features for each
- submit next week
  - by 9am Tue, email tmm@cs.ubc.ca with subject JOURN Week 1
  - reflections on what you've found in the 7 datasets
    - text illustrated by screenshots of what you've created, in PDF format
  - what did you find in the vis?
    - could you tell a story to others? could you get a sense of the story for yourself? did you find nothing useful?