Data and Encodings

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Previously in CSCM27...

- Name the four problem types in the Nested Model
- How can they be evaluated?
- When addressing a problem, where do we need to look?

Previously in CSCM27... (2)

- We now begin to look at data types
- And how to effectively encode them

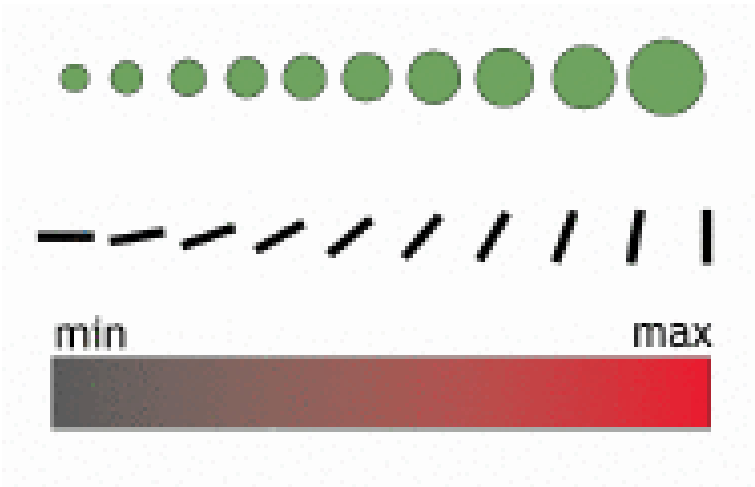
Data and Encodings

Thanks

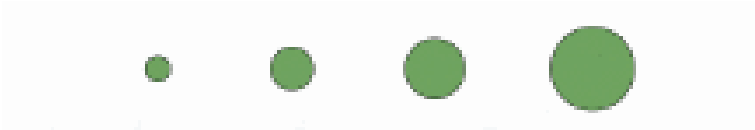
- Huge thanks to Tamara Munzner (my PhD adviser)
- Many of the figures are from her work
- This lecture is based off of her lectures

Data Types

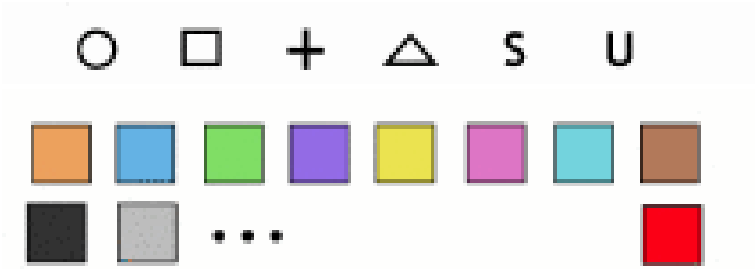
- continuous (quantitative)
  - 10 inches, 17 inches, 23 inches



- ordered (ordinal)
  - small, medium, large
  - days: Sun, Mon, Tue, ...



- categorical (nominal)
  - apples, oranges, bananas



[graphics.stanford.edu/papers/polaris]

Marks

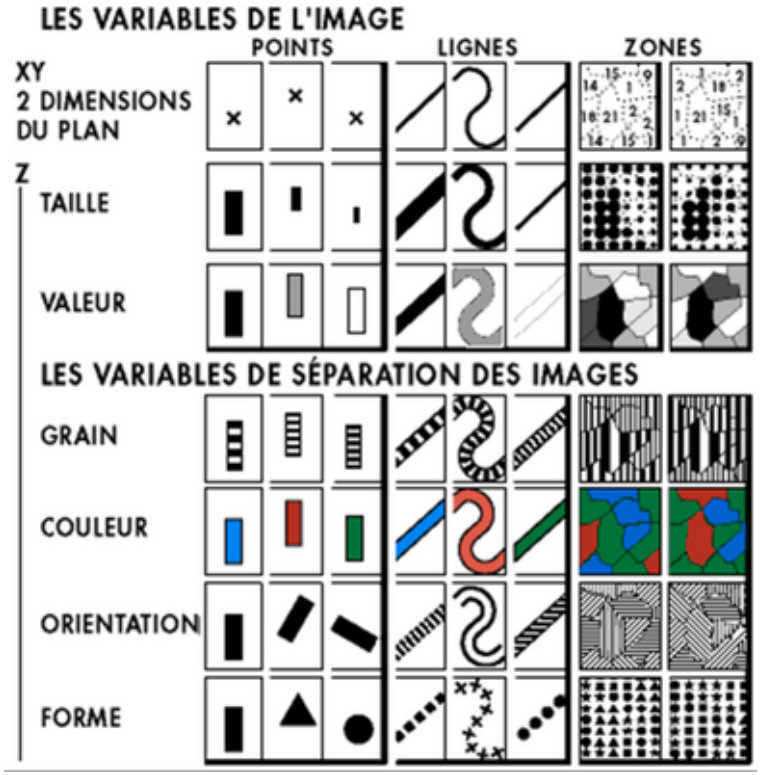
- Basic graphical element of an image
- Can be 0D, 1D, 2D, 3D

[T. Munzner, Visualization Analysis & Design, A. K. Peters, 2014]

Channels

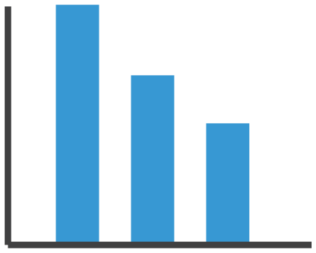
- attributes: visual/retinal variables
  - parameters control mark appearance
  - separable channels flowing from retina to brain

- x,y – position
- size
- greyscale
- color
- texture
- orientation
- shape



[Bertin, Semiology of Graphics, 1967 Gauthier-Villars, 1998 EHESS]

Example 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

[T. Munzner, Visualization Analysis & Design, A. K. Peters, 2014]

- Use marks and channels to analyse idiom structure

Marks and Channels in Altair

- At minimum, you should do the following tutorials:

```
https://github.com/uwdata/visualization-curriculum/
      blob/master/altair_introduction.ipynb
https://github.com/uwdata/visualization-curriculum/
      blob/master/altair_marks_encoding.ipynb
```

- API information in here:

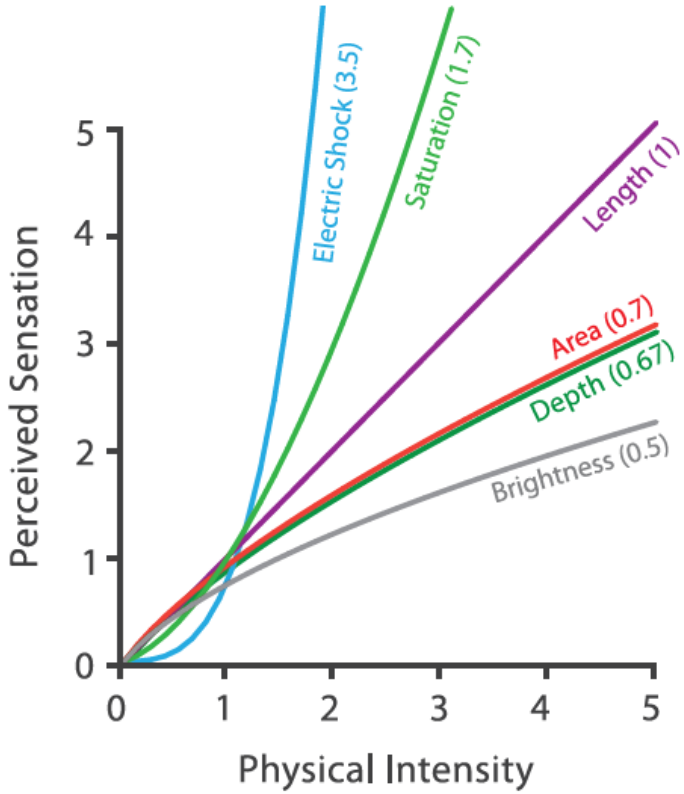
```
https://altair-viz.github.io/
```

- Start now.

Understanding How Humans Work

- Human information processing:
  - Perception
  - Attention
  - Memory
  - Vision

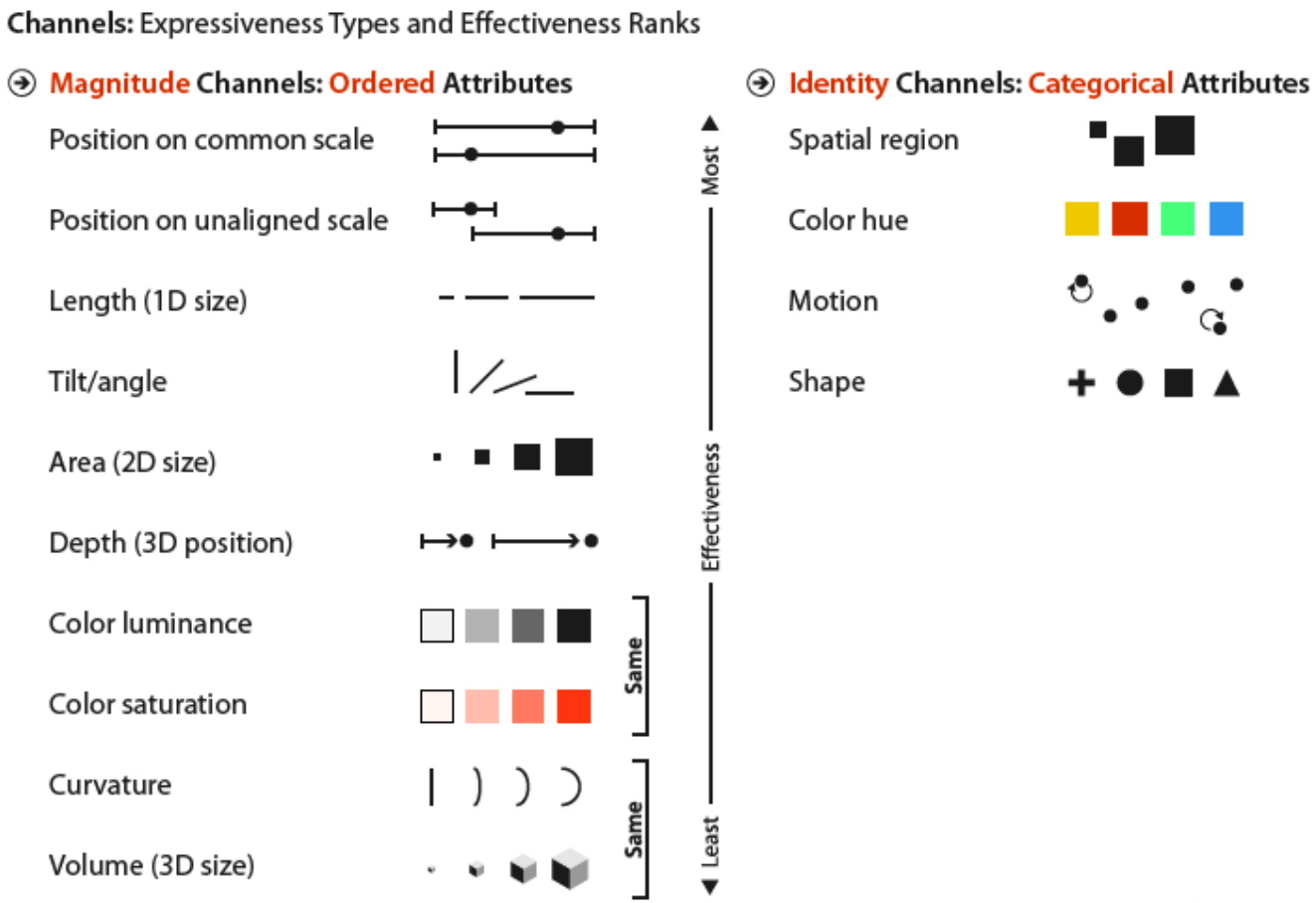
Perception of Channels



[T. Munzner, Visualization Analysis & Design, A. K. Peters, 2014]

- Not all channels are perceived the same

Effectiveness by Data Type



[T. Munzner, Visualization Analysis & Design, A. K. Peters, 2014]

- Channels encode data with different effectiveness

Perception: Constructivism

- Context:
  - used to resolve ambiguous stimuli,
  - requires some prior knowledge to make sense of the ambiguity
- Gestalt:
  - innate laws of organisation
  - partition and decomposition into entities that are readily recognisable

Perception: Constructivism

Bottom-up vs. Top-down Perception

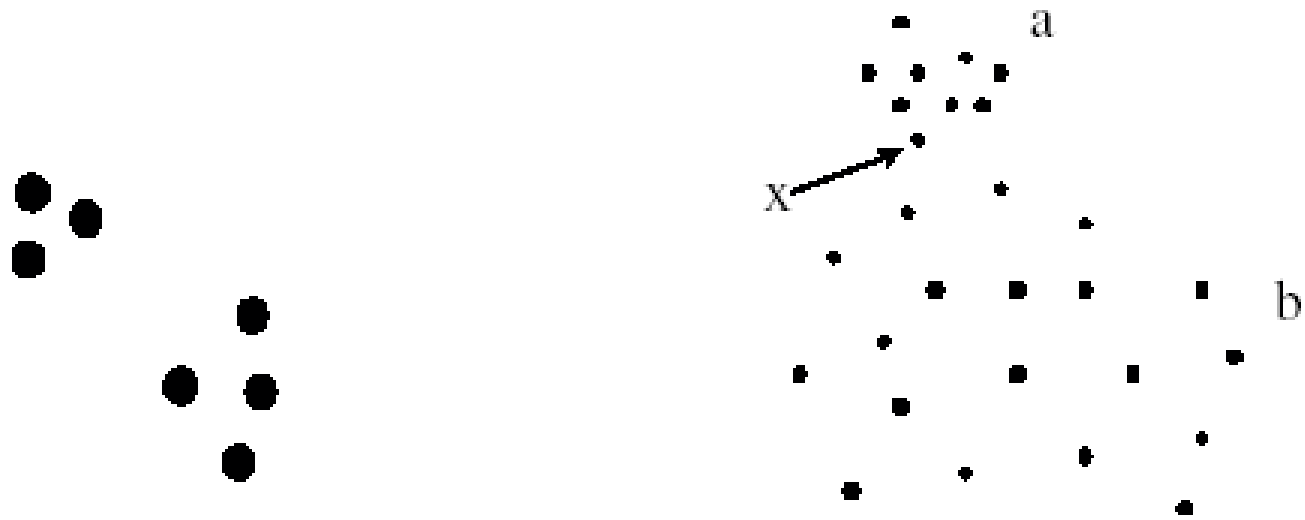
Bottom-up vs. Top-down Perception

- Bottom-up uses features of stimulus
- Top-down uses context
  - temporal (auditory perception), spatial (visual perception)
  - draws on long-term memory

Gestalt Laws

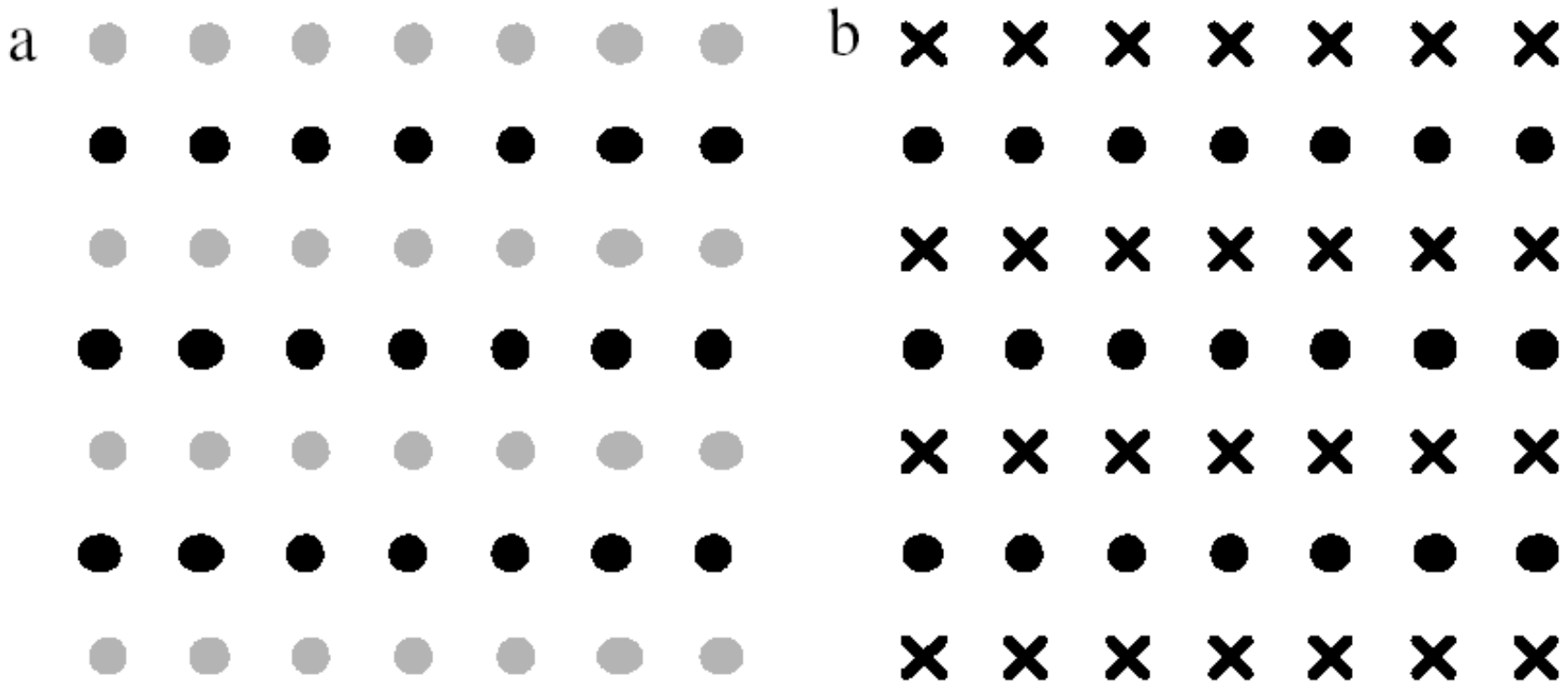
- principles of pattern perception
  - "gestalt": German for "pattern"
  - original proposed mechanisms wrong
  - rules themselves still very useful
- Pragnatz
  - simplest possibility wins

Proximity



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

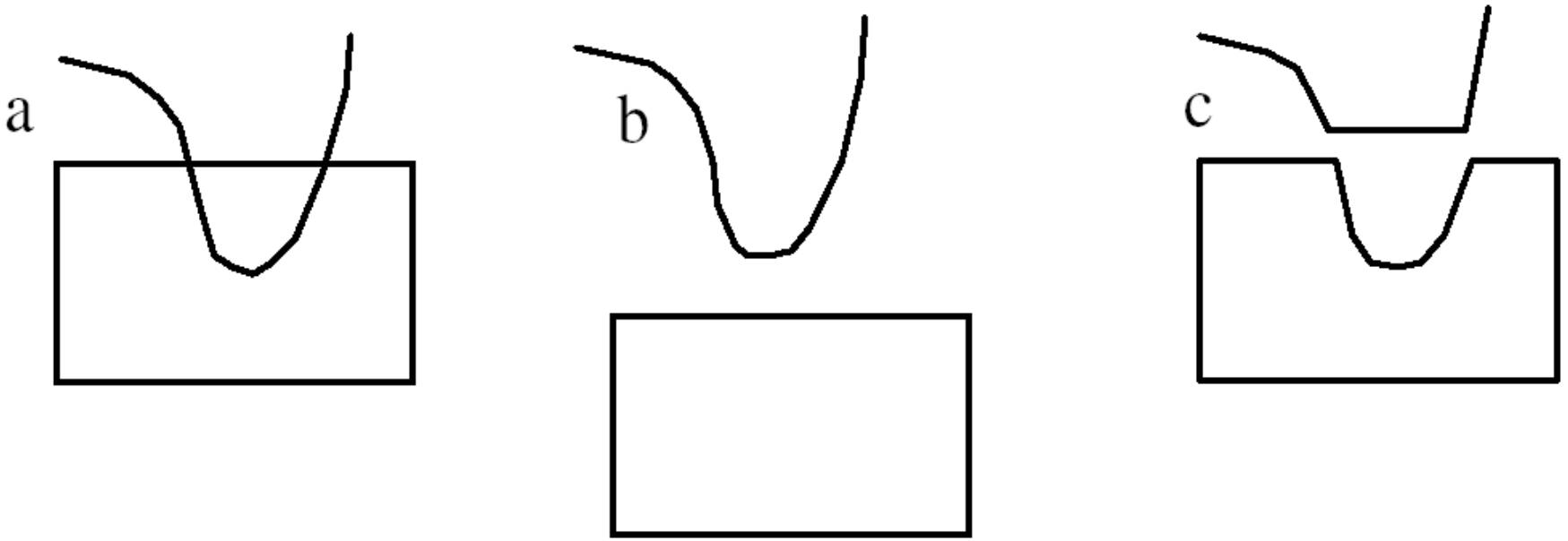
Similarity



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Continuity

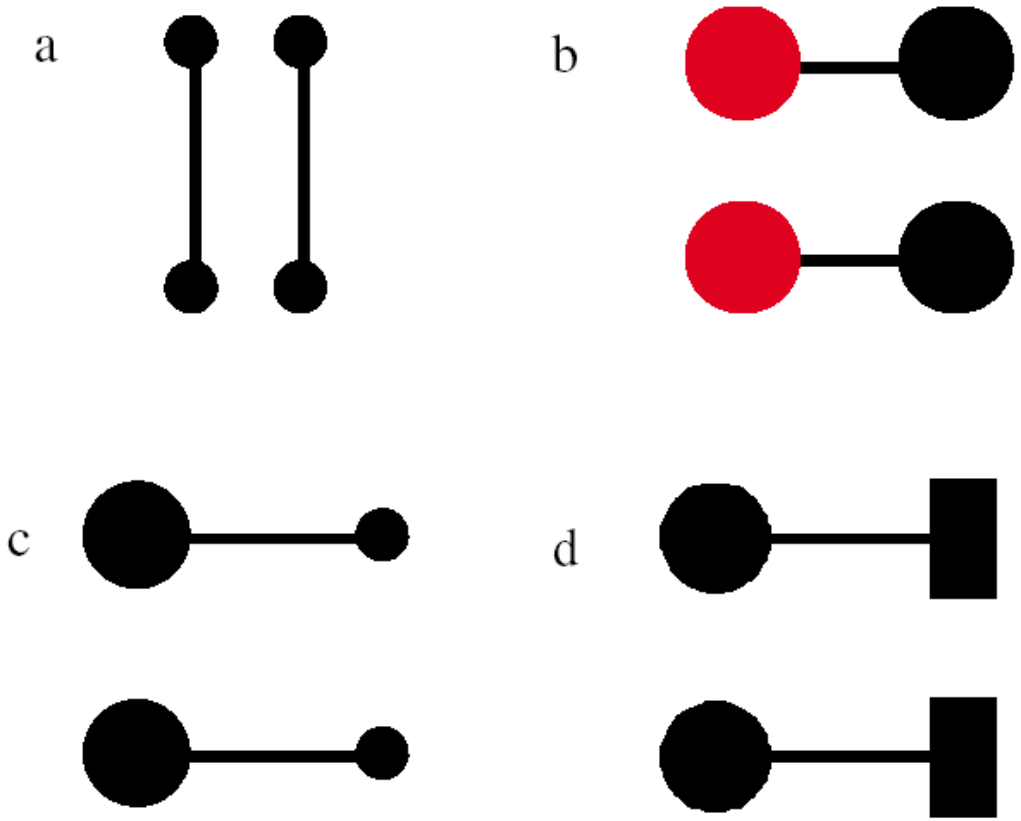
- smooth not abrupt change
- overrules proximity



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Connectedness

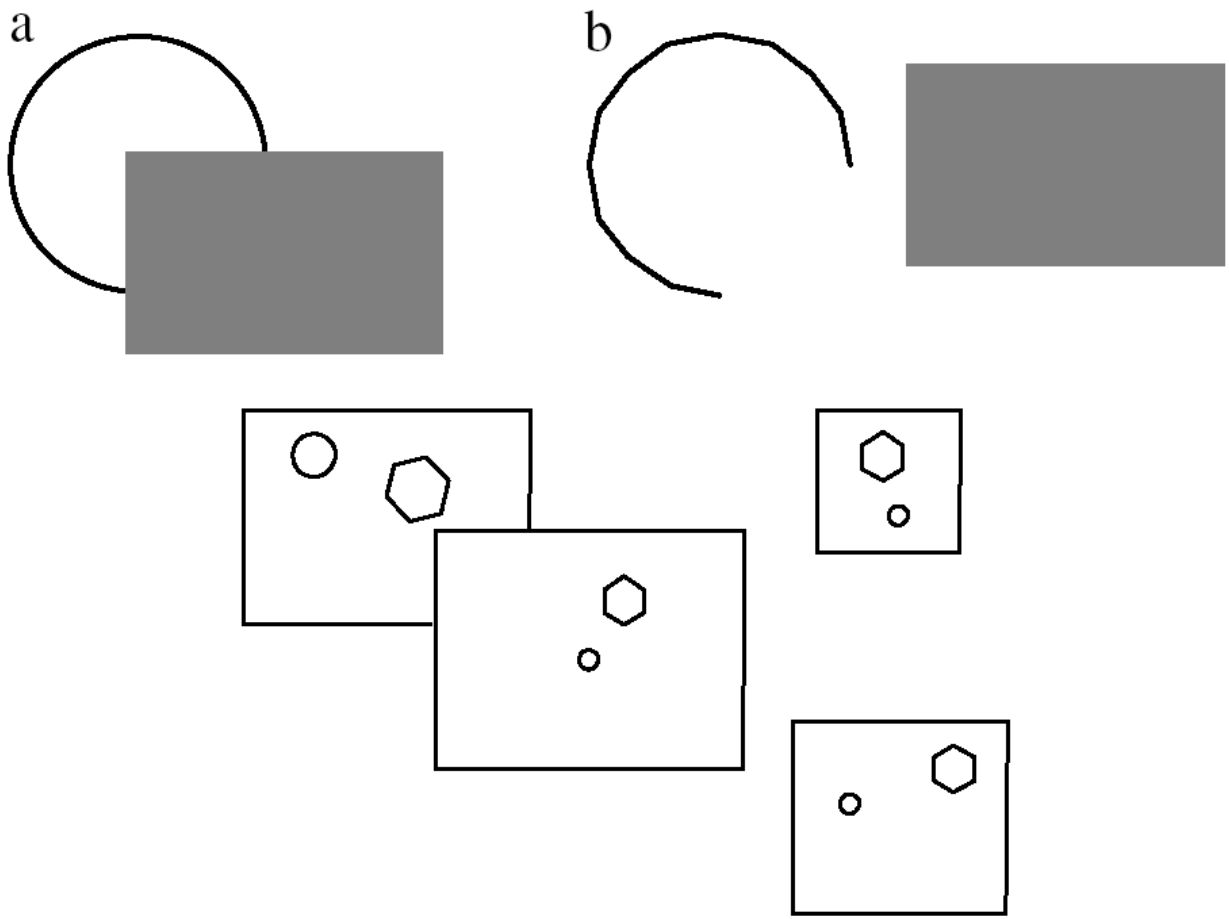
- can overrule size, shape



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Closure

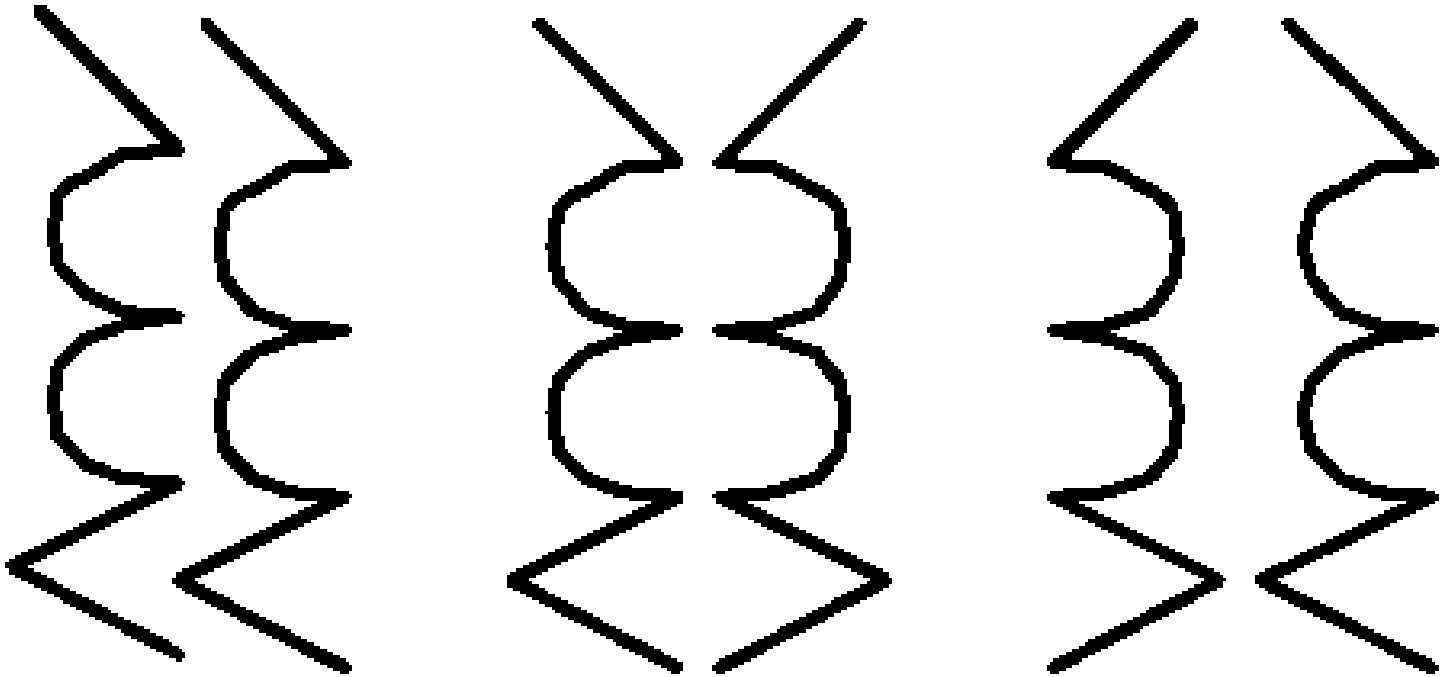
- overrules proximity



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Symmetry

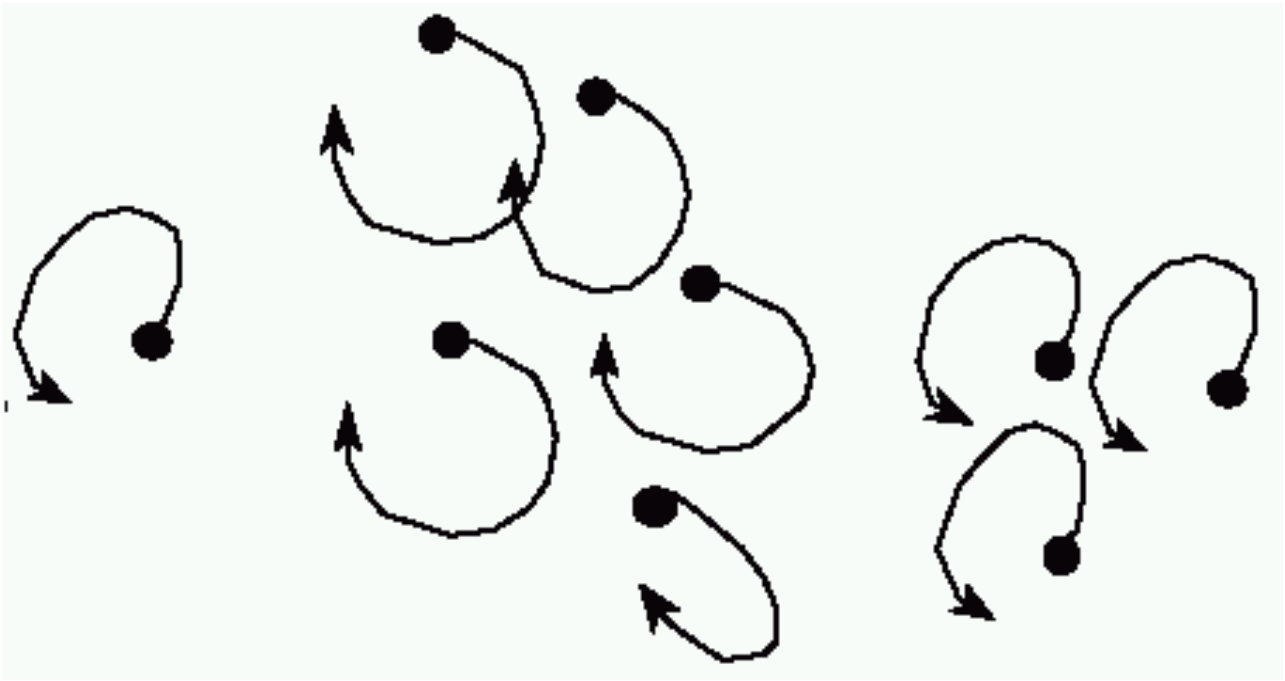
- emphasises relationships



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Common Fate

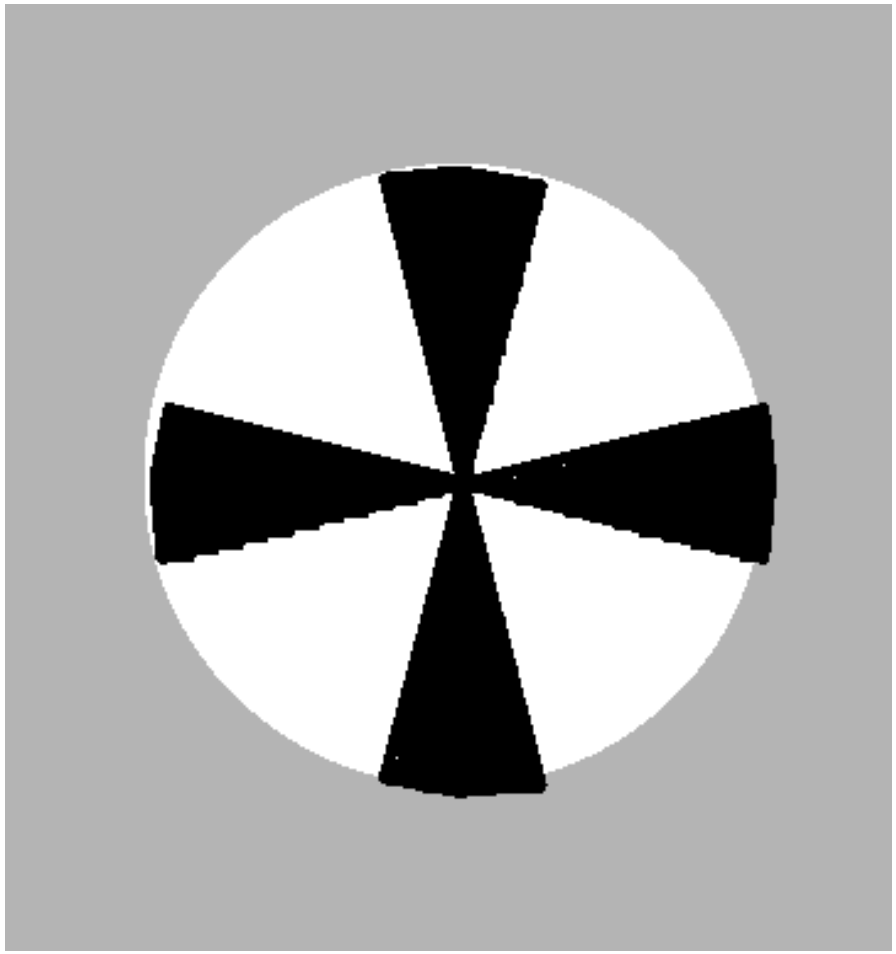
- demo
- `http://tepserver.ucsd.edu/~jlevin/gp/time-example-common-fate/`



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Relative Size

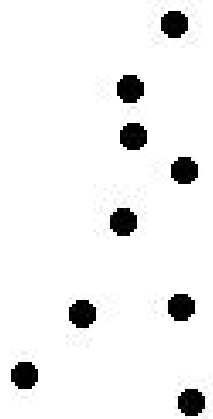
- smaller components perceived as objects



[Information Visualization: Perception for Design. Ware, Morgan Kaufmann, 2000]

Motion

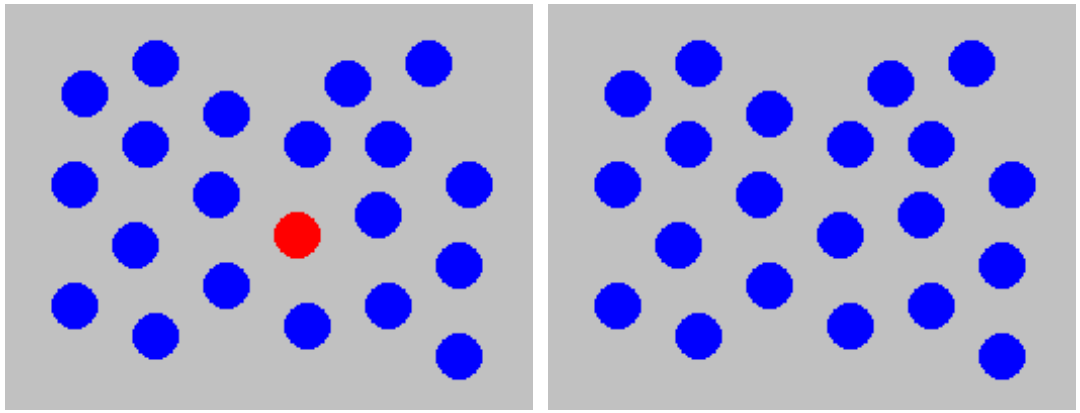
- works for preattentive/grouping
- less studied than static dimensions
  - Michotte on causality
  - newer InfoVis/motion work by Lyn Bartram



[www.psy.vanderbilt.edu/faculty/blake/biowalker.gif]

Preattentive Visual Dimensions

- color (hue) alone: preattentive
  - attentional system not invoked
  - search speed independent of distractor count

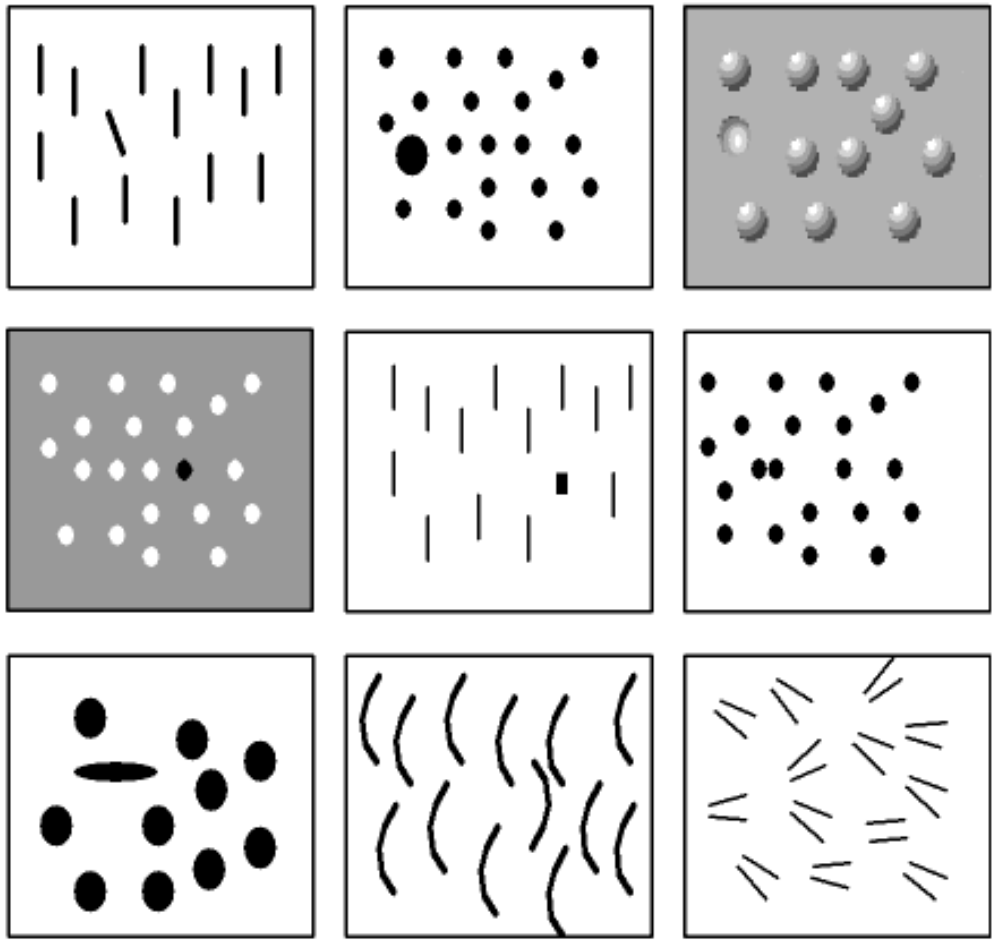


- demo

[Chris Healey, Preattentive Processing, www.csc.ncsu.edu/faculty/healey/PP/PP.html]

Many Preattentive Visual Dimensions

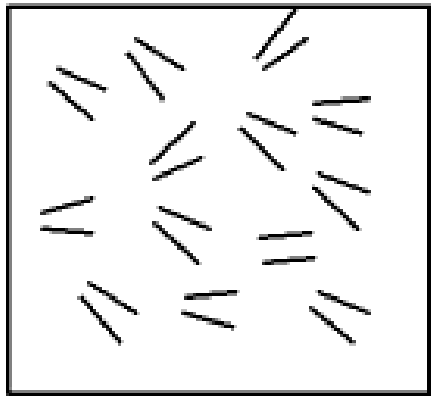
hue
shape
texture
length
width
size
orientation
curvature
intersection
intensity
flicker
direction of motion
stereoscopic depth
light direction, . . .



[www.csc.ncsu.edu/faculty/healey/PP/PP.html]

Not All Dimensions Preattentive

parallelism



[www.csc.ncsu.edu/faculty/healey/PP/PP.html]

Preattentive Visual Dimensions

- color alone: preattentive
- shape alone: preattentive

- combined hue and shape (demo)
  - requires attention
  - search speed linear with distractor count

[www.csc.ncsu.edu/faculty/healey/PP/PP.html]

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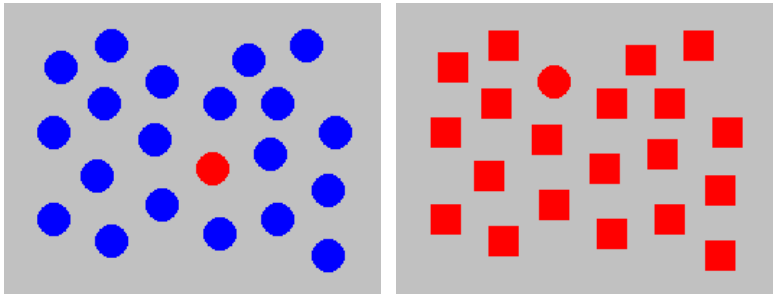

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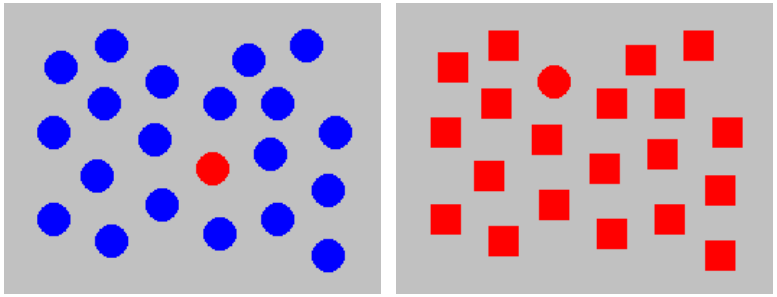

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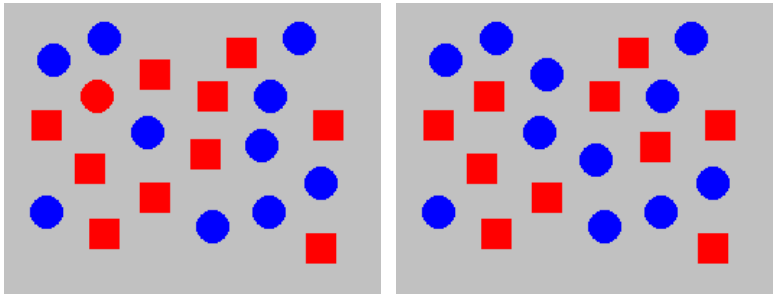

[www.csc.ncsu.edu/faculty/healey/PP/PP.html]

Summary

- Data types and effective encodings
- Perceptual factors in data encodings
- Gestalt principles
- Preattentive encodings