

Visualization Analysis & Design

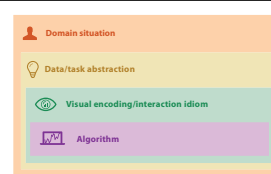
Marks & Channels (Ch 5) I

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 @tamaramunzner



Visual encoding

- how to systematically analyze idiom structure?



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Visual encoding

- how to systematically analyze idiom structure?



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Visual encoding

- how to systematically analyze idiom structure?

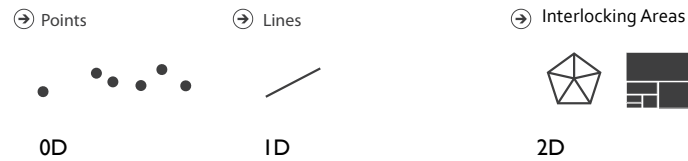


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- marks & channels
 - marks: represent items or links
 - channels: change appearance of marks based on attributes

Marks for items

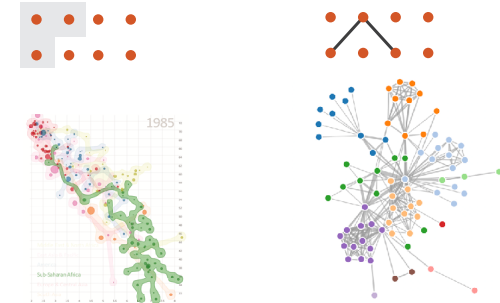
- basic geometric elements



- 3D mark: volume, rarely used

Marks for links

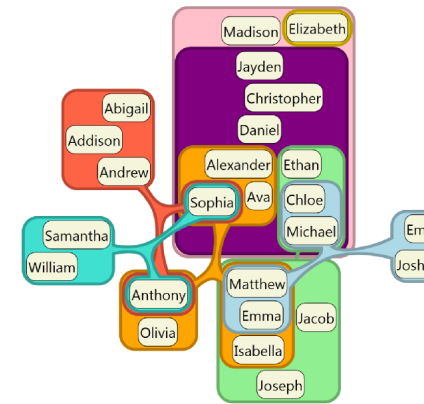
- Containment
- Connection



vialab.science.uoit.ca/portfolio/bubblesets <https://observablehq.com/@d3/force-directed-graph>

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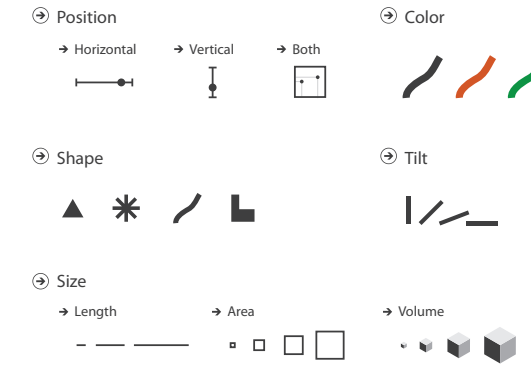
Containment can be nested



[Untangling Euler Diagrams, Riche and Dwyer, 2010]

Channels

- control appearance of marks
 - proportional to or based on attributes



- many names
 - visual channels
 - visual variables
 - retinal channels
 - visual dimensions
 - ...

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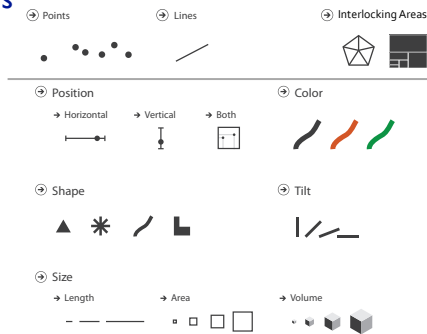
Definitions: Marks and channels

- marks
 - geometric primitives



Definitions: Marks and channels

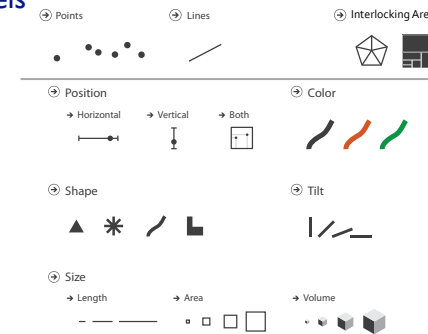
- marks
 - geometric primitives
- channels
 - control appearance of marks



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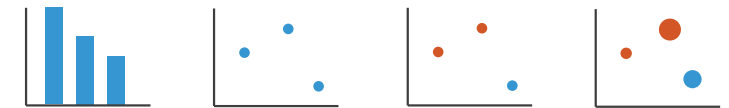
Definitions: Marks and channels

- marks
 - geometric primitives
- channels
 - control appearance of marks
- channel properties differ
 - type & amount of information that can be conveyed to human perceptual system



Visual encoding

- analyze idiom structure as combination of marks and channels



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Visual encoding

- analyze idiom structure as combination of marks and channels



1: vertical position

mark: line

Visual encoding

- analyze idiom structure as combination of marks and channels



1: vertical position

2: vertical position
horizontal position

mark: line

mark: point

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Visual encoding

- analyze idiom structure as combination of marks and channels



1: vertical position

2: vertical position
horizontal position

3: vertical position
horizontal position
color hue

mark: line

mark: point

mark: point

Visual encoding

- analyze idiom structure as combination of marks and channels



1: vertical position

2: vertical position
horizontal position

3: vertical position
horizontal position
color hue

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

mark: line

mark: point

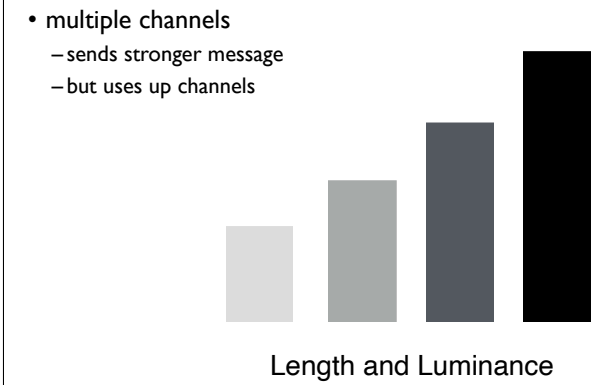
mark: point

mark: point

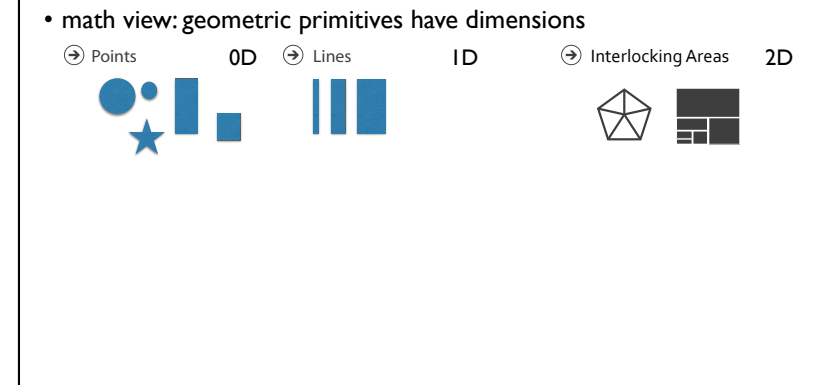
15

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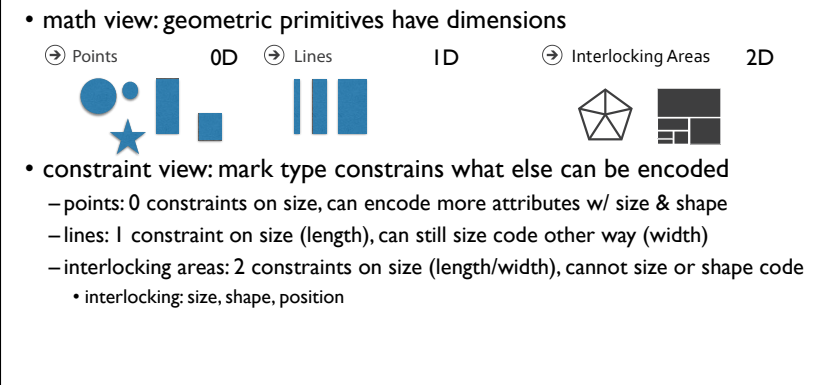
Redundant encoding



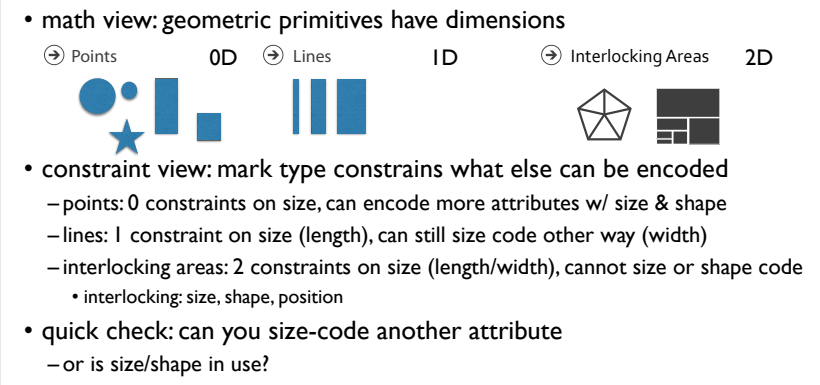
Marks as constraints



Marks as constraints



Marks as constraints



Scope of analysis

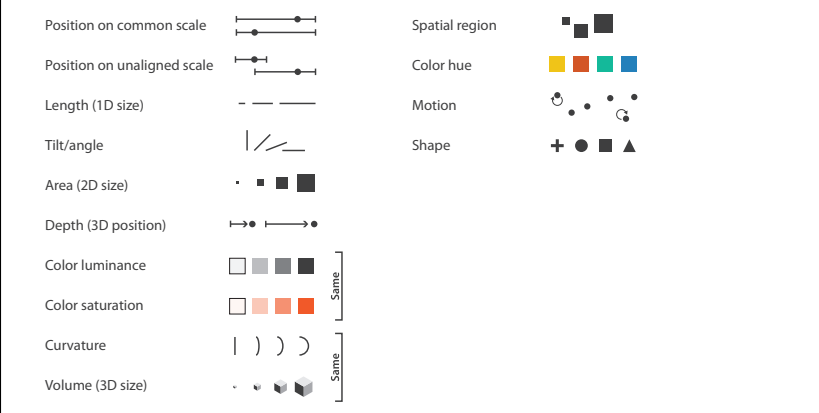
- simplifying assumptions: one mark per item, single view
- later on
 - multiple views
 - multiple marks in a region (glyph)
 - some items not represented by marks (aggregation and filtering)

When to use which channel?

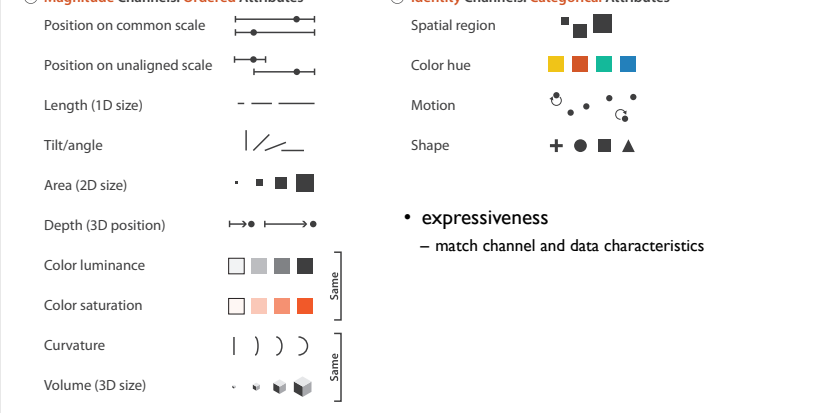
expressiveness
match channel type to data type

effectiveness
some channels are better than others

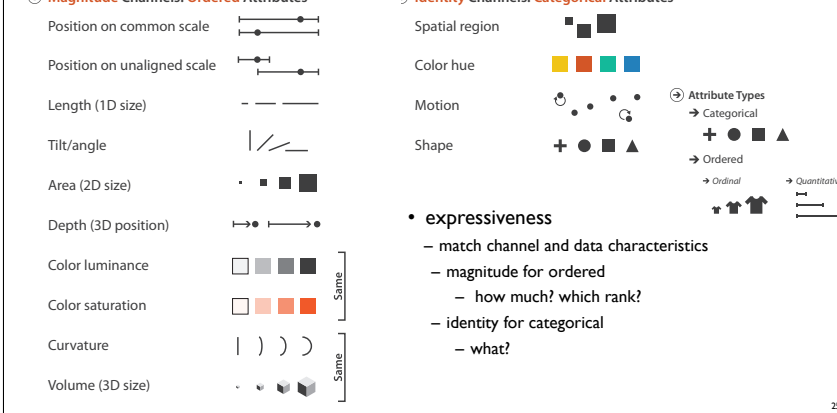
Channels: Rankings



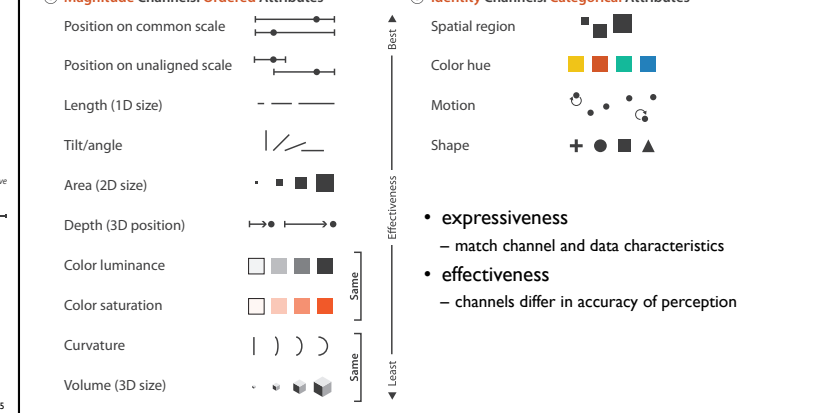
Channels: Rankings



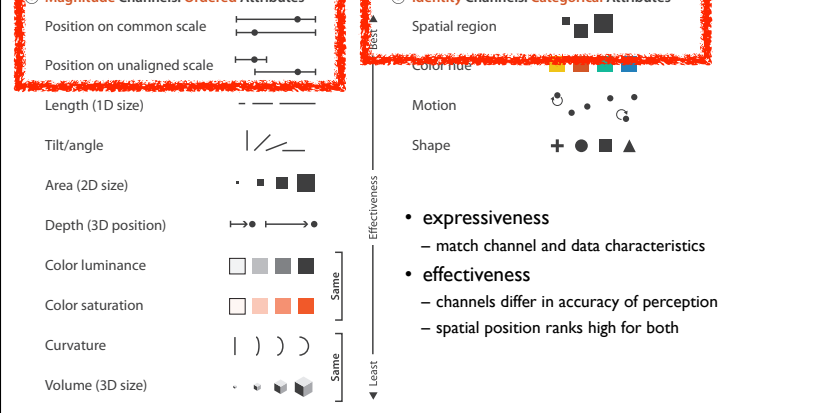
Channels: Rankings



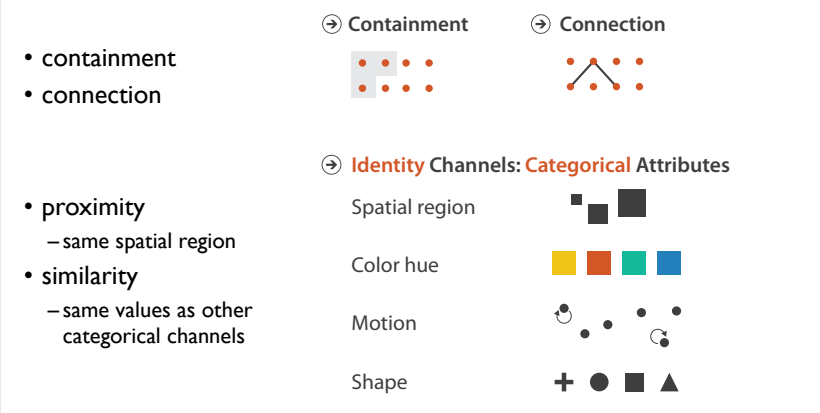
Channels: Rankings



Channels: Rankings



Grouping



Visualization Analysis & Design

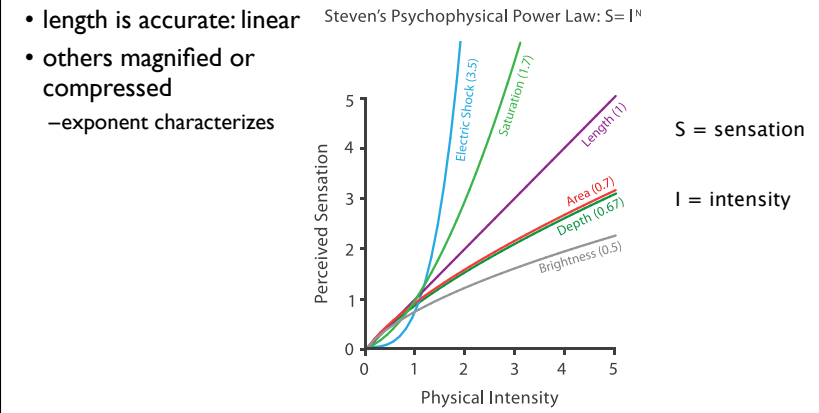
Marks & Channels (Ch 5) II

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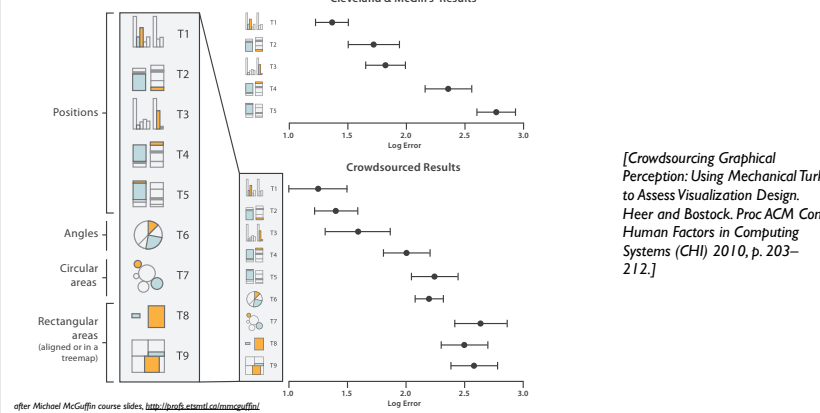
Channel effectiveness

- accuracy: how precisely can we tell the difference between encoded items?
- discriminability: how many unique steps can we perceive?
- separability: is our ability to use this channel affected by another one?
- popout: can things jump out using this channel?

Accuracy: Fundamental theory



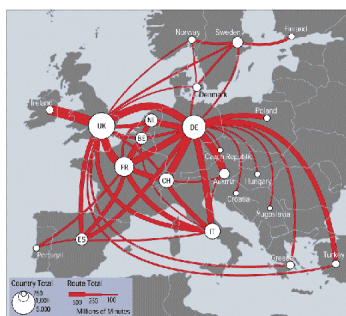
Accuracy: Vis experiments



Discriminability: How many usable steps?

- must be sufficient for number of attribute levels to show

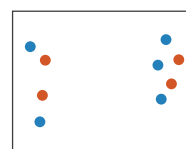
– linewidth: few bins



[mapa.mundi.net/maps/maps_014/telegeography.html]

Separability vs. Integrality

Position
+ Hue (Color)



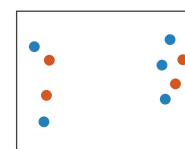
Fully separable

2 groups each

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Separability vs. Integrality

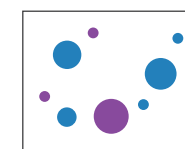
Position
+ Hue (Color)



Fully separable

2 groups each

Size
+ Hue (Color)



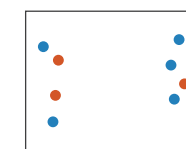
Some interference

2 groups each

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Separability vs. Integrality

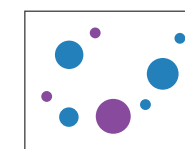
Position
+ Hue (Color)



Fully separable

2 groups each

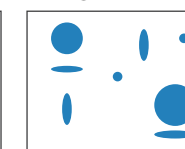
Size
+ Hue (Color)



Some interference

2 groups each

Width
+ Height

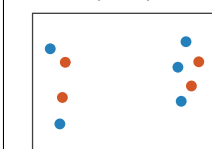


Some/significant interference
3 groups total:
integral area

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Separability vs. Integrality

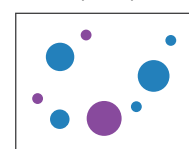
Position
+ Hue (Color)



Fully separable

2 groups each

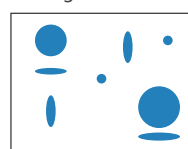
Size
+ Hue (Color)



Some interference

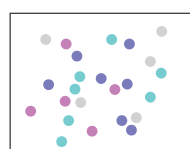
2 groups each

Width
+ Height



Some/significant interference
3 groups total:
integral area

Red
+ Green



Major interference
4 groups total:
integral hue

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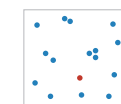
Popout

- find the red dot
- how long does it take?

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Popout

- find the red dot
- how long does it take?



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Popout

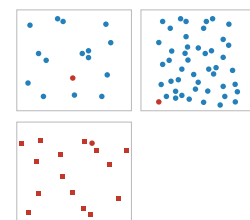
- find the red dot
- how long does it take?



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Popout

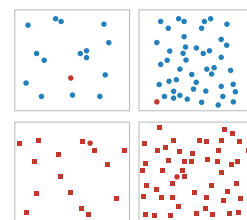
- find the red dot
- how long does it take?



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Popout

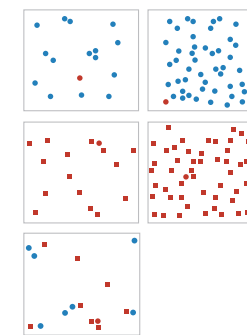
- find the red dot
- how long does it take?



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Popout

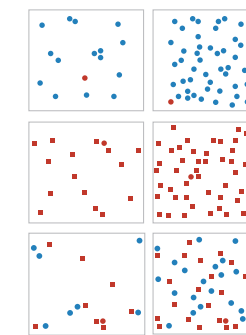
- find the red dot
- how long does it take?



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Popout

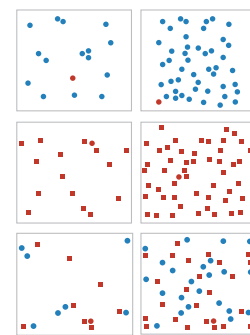
- find the red dot
- how long does it take?



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Popout

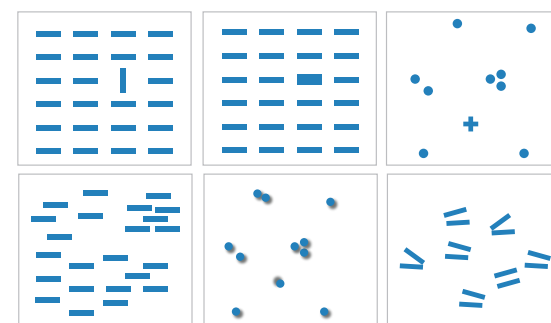
- find the red dot
- how long does it take?
- parallel processing on many individual channels
- speed independent of distractor count
- speed depends on channel and amount of difference from distractors
- serial search for (almost all) combinations
- speed depends on number of distractors



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Popout

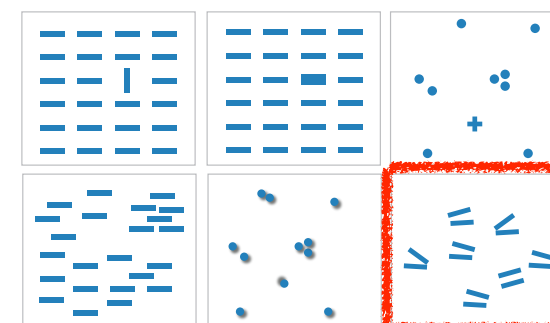
- many channels
- tilt, size, shape, proximity, shadow, direction, ...



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Popout

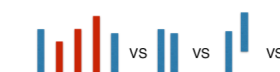
- many channels
- tilt, size, shape, proximity, shadow, direction, ...
- but not all!
- parallel line pairs do not pop out from tilted pairs



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Factors affecting accuracy

- alignment
- distractors
- distance
- common scale / alignment



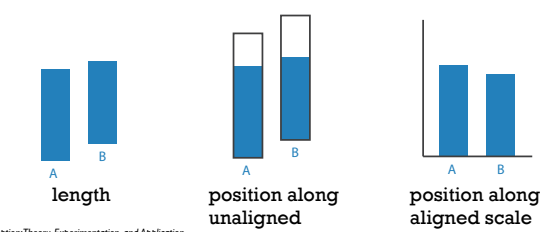
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Relative vs. absolute judgements

- perceptual system mostly operates with relative judgements, not absolute

Relative vs. absolute judgements

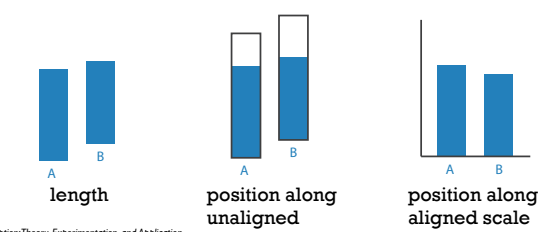
- perceptual system mostly operates with relative judgements, not absolute
 - that's why accuracy increases with common frame/scale and alignment



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 vs. absolute judgements

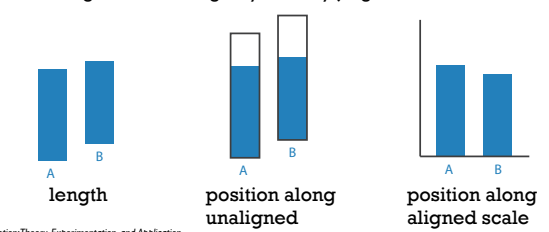
- perceptual system mostly operates with relative judgements, not absolute
 - that's why accuracy increases with common frame/scale and alignment
 - Weber's Law: ratio of increment to background is constant



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 vs. absolute judgements

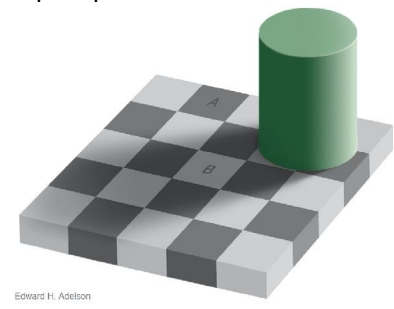
- perceptual system mostly operates with relative judgements, not absolute
 - that's why accuracy increases with common frame/scale and alignment
 - Weber's Law: ratio of increment to background is constant
 - filled rectangles differ in length by 1:9, difficult judgement
 - white rectangles differ in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



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

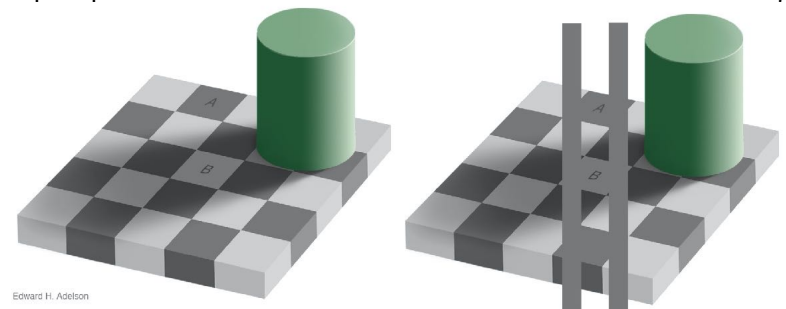
- perception of luminance is contextual based on contrast with surroundings



Edward H. Adelson

Relative luminance judgements

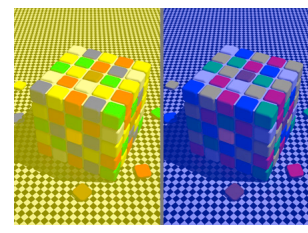
- perception of luminance is contextual based on contrast with surroundings



Edward H. Adelson

Relative color judgements

- color constancy across broad range of illumination conditions



Relative color judgements

- color constancy across broad range of illumination conditions

