

Information Visualization

W05: Marks and Channels

Graduate School of System Informatics

Department of Computational Science

Naohisa Sakamoto Akira Kageyama

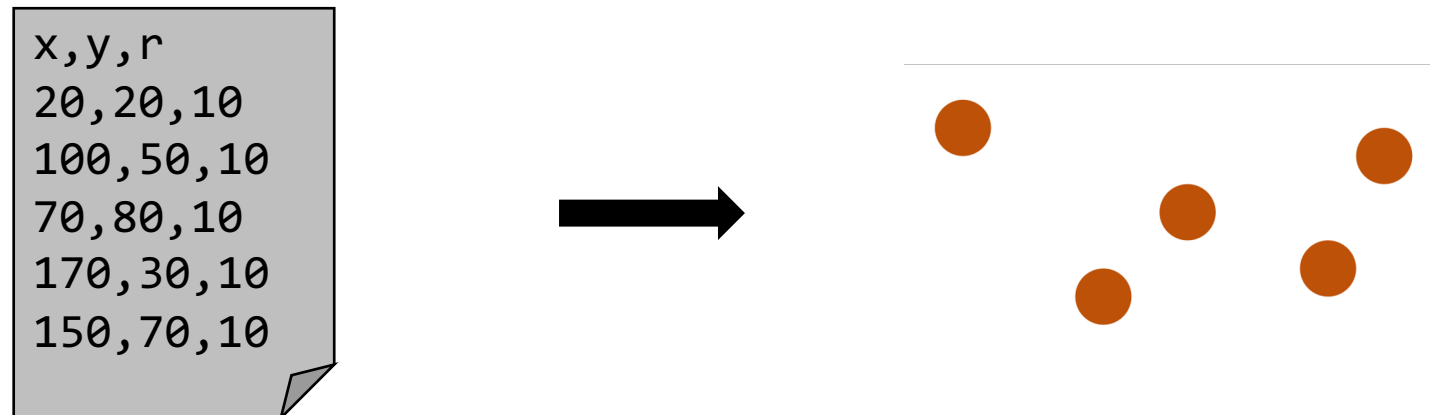
April 26, 2022

Schedule

- W01 4/12 Guidance
- W02 4/13 JavaScript Programming
- W03 4/19 Data and Tasks
- W04 4/20 Reading Data
- W05 4/26 Marks and Channels
- W06 4/27 Creating Data Plot - Scatter plot
- W07 5/10 Visualization Idioms
- W08 5/11 Creating Data Plot - Bar/Pie/Line/Area chars

Visual Encoding

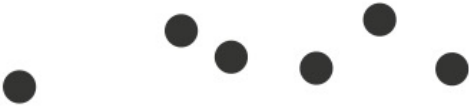
- **Marks**
 - Represent items or links
- **Channels**
 - Change appearance of marks based on attributes



Marks

- Items/Nodes

➞ Points



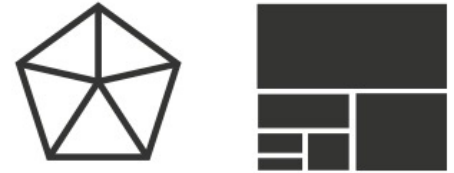
0-D

➞ Lines



1-D

➞ Areas

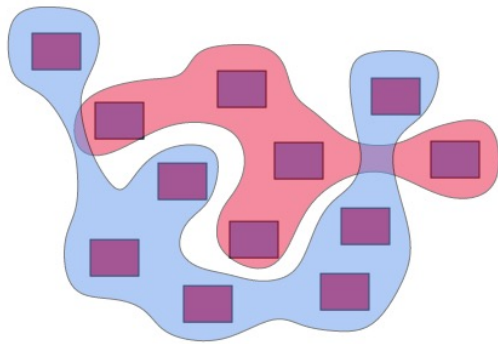


2-D

Marks

- Links

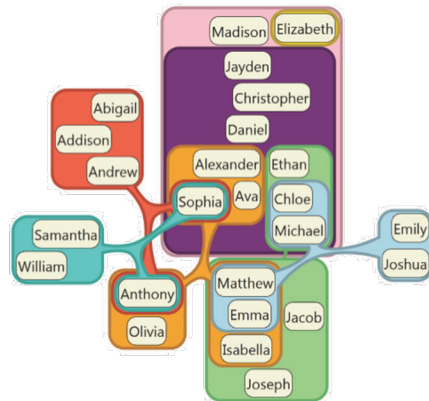
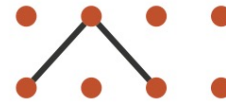
➔ Containment



Bubble Sets

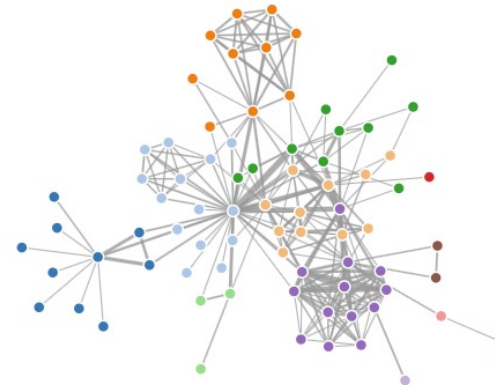
<https://github.com/IosuaKrause/bubblesets-js>

➔ Connection



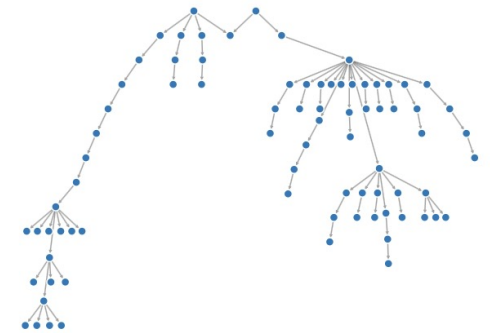
Untangling Euler Diagrams

N.H. Riche et al., IEEE TVCG, Vol16, No.6, 2010



Unconstrained graph layout

<https://ialab.it.monash.edu/webcola/examples/unconstrainedsmallworld.html>



Directed Graph with downward-pointing edges

<https://ialab.it.monash.edu/webcola/examples/downwardedges.html>

Channels

- **Control appearance of marks**
 - Proportional to or based on attributes

➔ Position

➔ Horizontal



➔ Vertical



➔ Both



➔ Shape



➔ Color

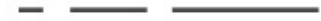


➔ Tilt



➔ Size

➔ Length



➔ Area

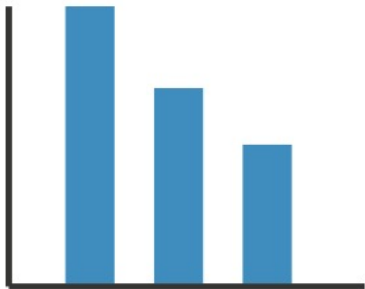


➔ Volume



Visual Encoding

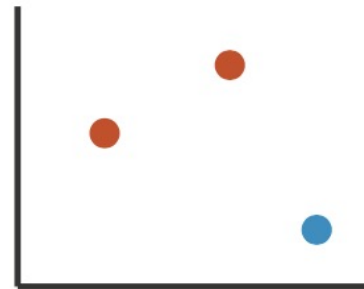
- **Marks & Channels**



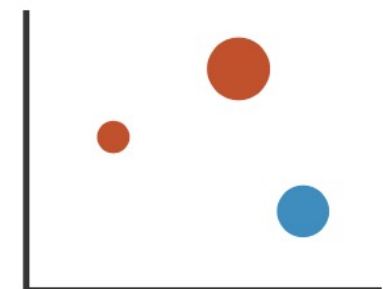
- **Mark: Line**
- **Channels: 1**
 - Vertical pos.



- **Mark: Point**
- **Channels: 2**
 - Vertical pos.
 - Horizontal pos.



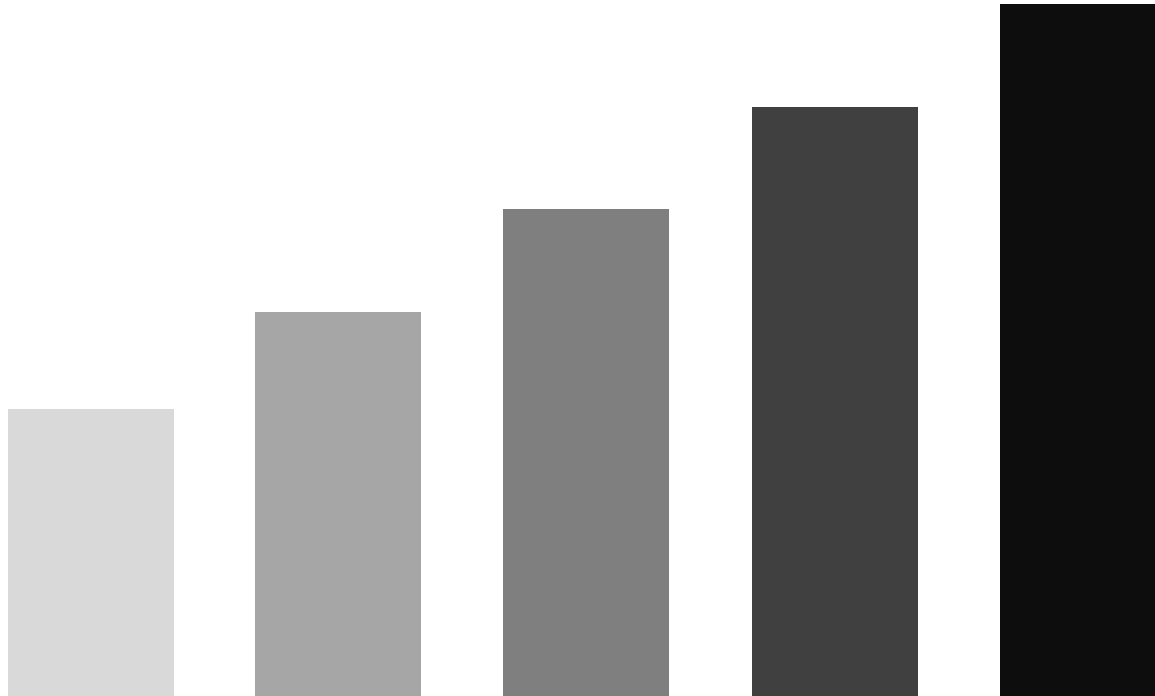
- **Mark: Point**
- **Channels: 3**
 - Vertical pos.
 - Horizontal pos.
 - Color



- **Mark: Point**
- **Channels: 4**
 - Vertical pos.
 - Horizontal pos.
 - Color
 - Size

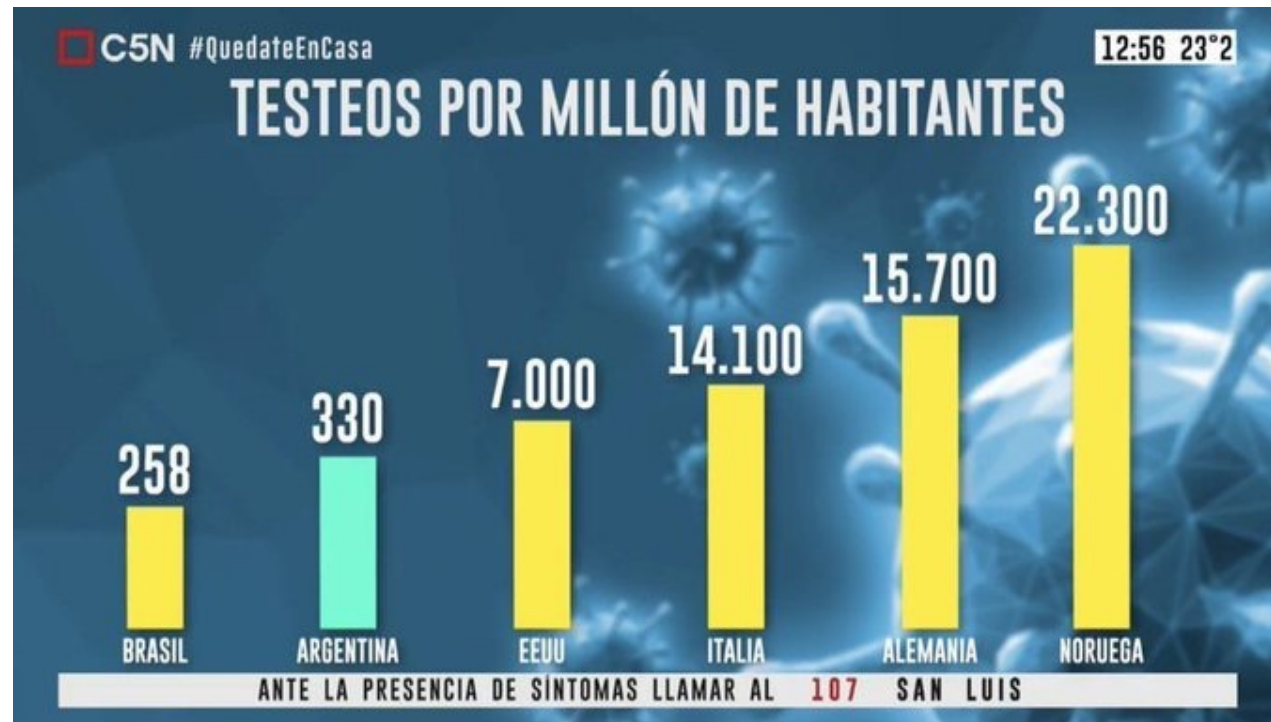
Visual Encoding

- Marks & Channels



Visual Encoding

- Marks & Channels



EEUU: USA
Alemania: Germany
Noruega: Norway

Number of COVID-19 tests per million of people

Source: https://www.reddit.com/r/dataisugly/comments/g6b1vu/argentina_is_testing_like_crazy_oh_wait_let_me/

Expressiveness and Effectiveness

- **Expressiveness principle**

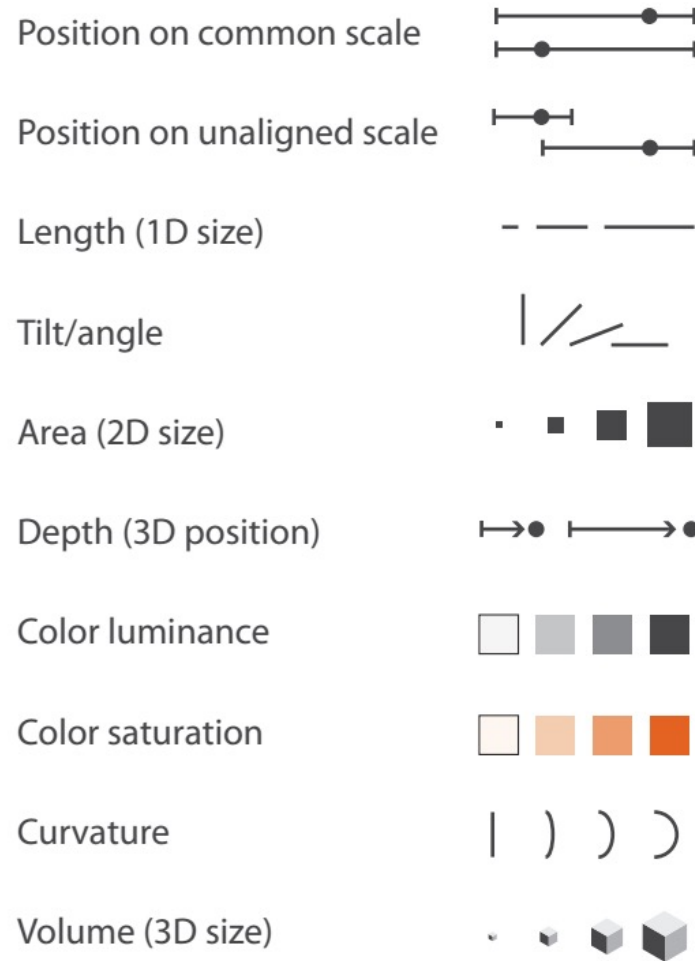
- Match channel and data characteristics
 - Magnitude for ordered
 - Identity for categorical

- **Effectiveness principle**

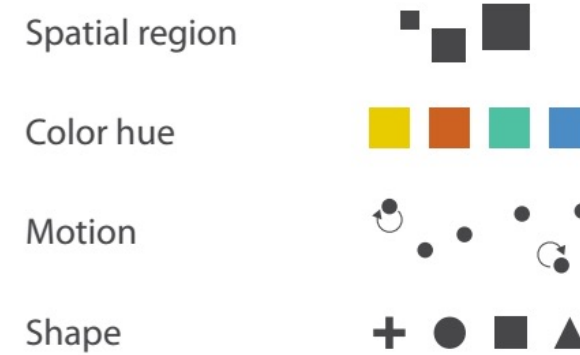
- Encode most important attributes with highest ranked channels

Channel Rankings

➔ Magnitude Channels: Ordered Attributes

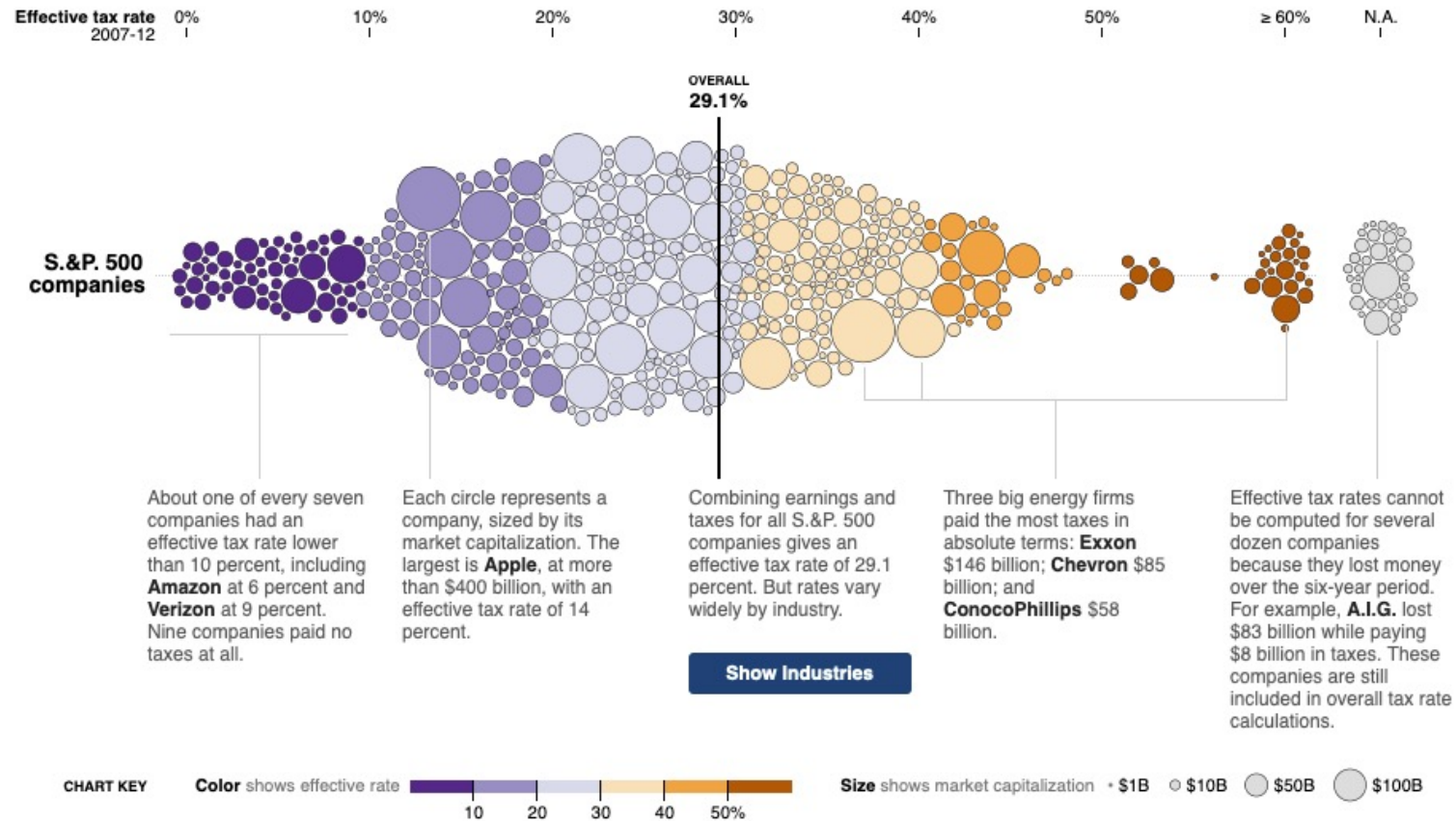


➔ Identity Channels: Categorical Attributes



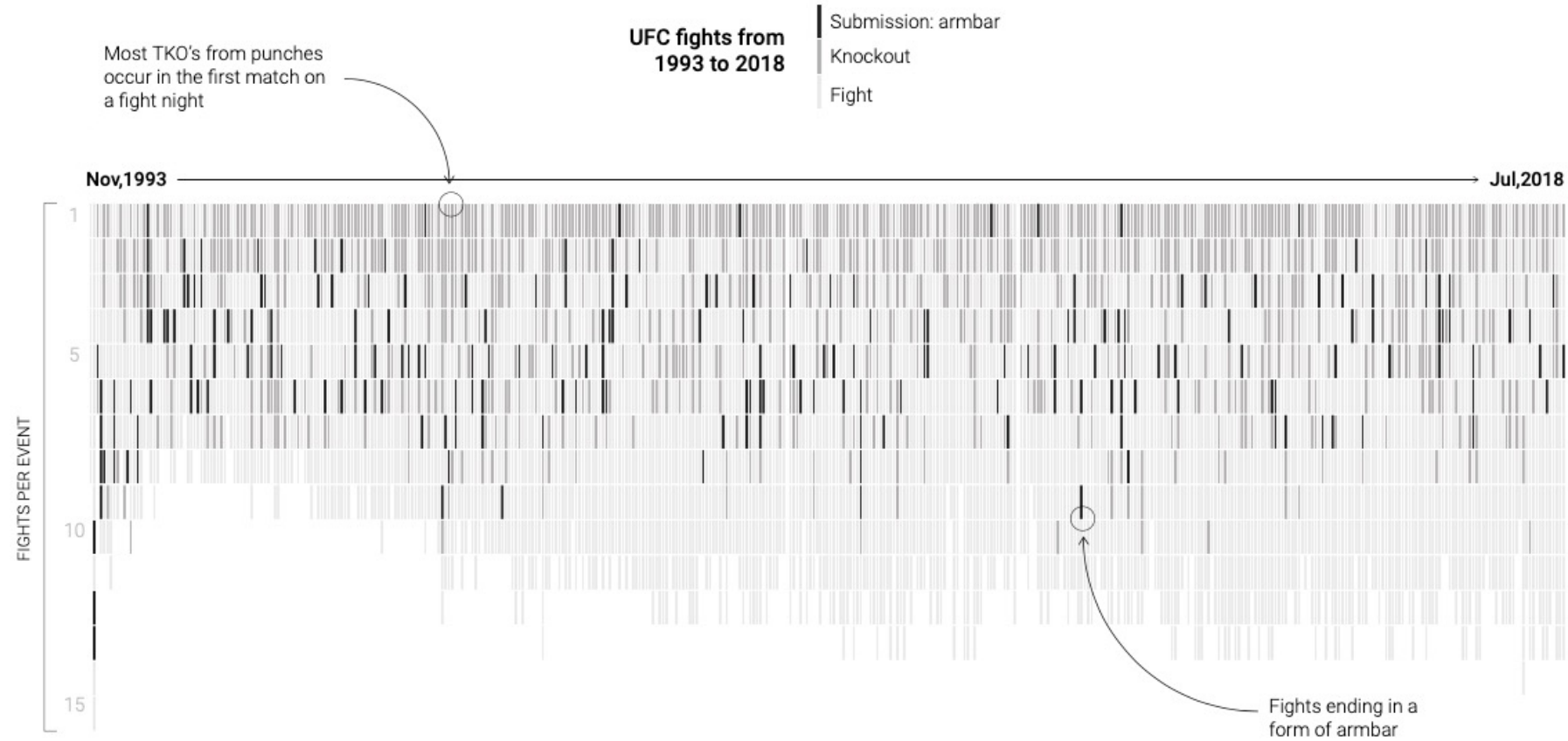
Channels?

- Tax Rates



Marks?

- UFC Fights



Channel Effectiveness

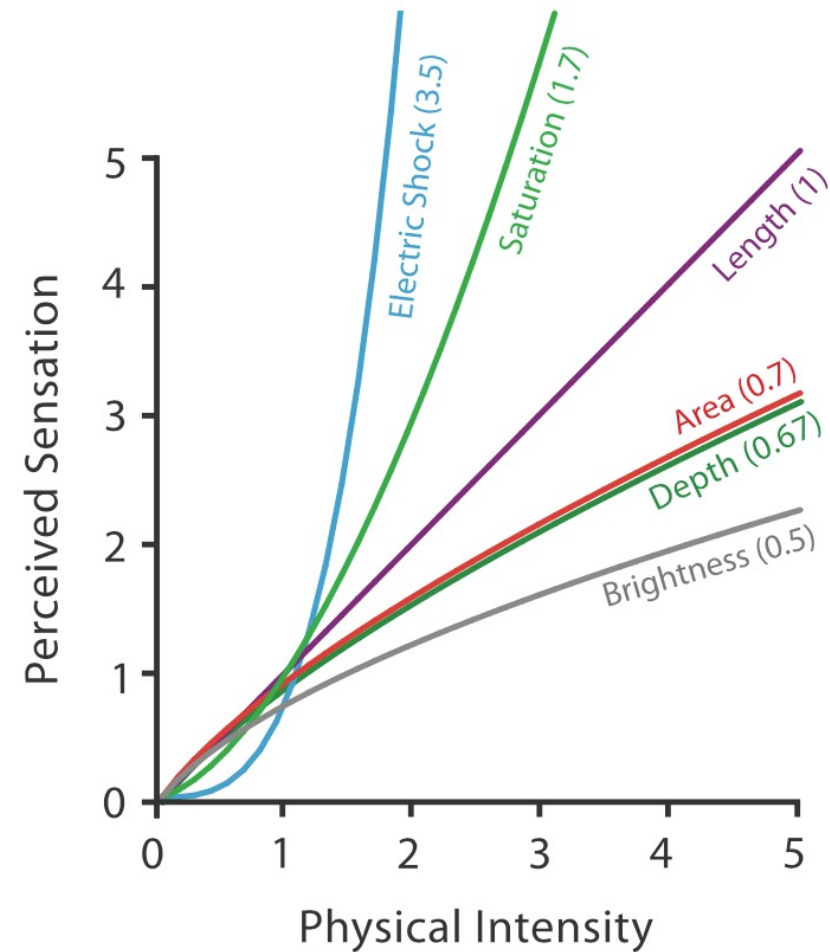
- **Accuracy**
 - How precisely can we tell the difference between encode items?
- **Discriminability**
 - How many unique steps can we perceive?
- **Separability**
 - Is our ability to use this channel affected by another one?
- **Popout**
 - Can things jump out using this channel?

Accuracy

- Stevens's Power Law

$$S = I^n$$

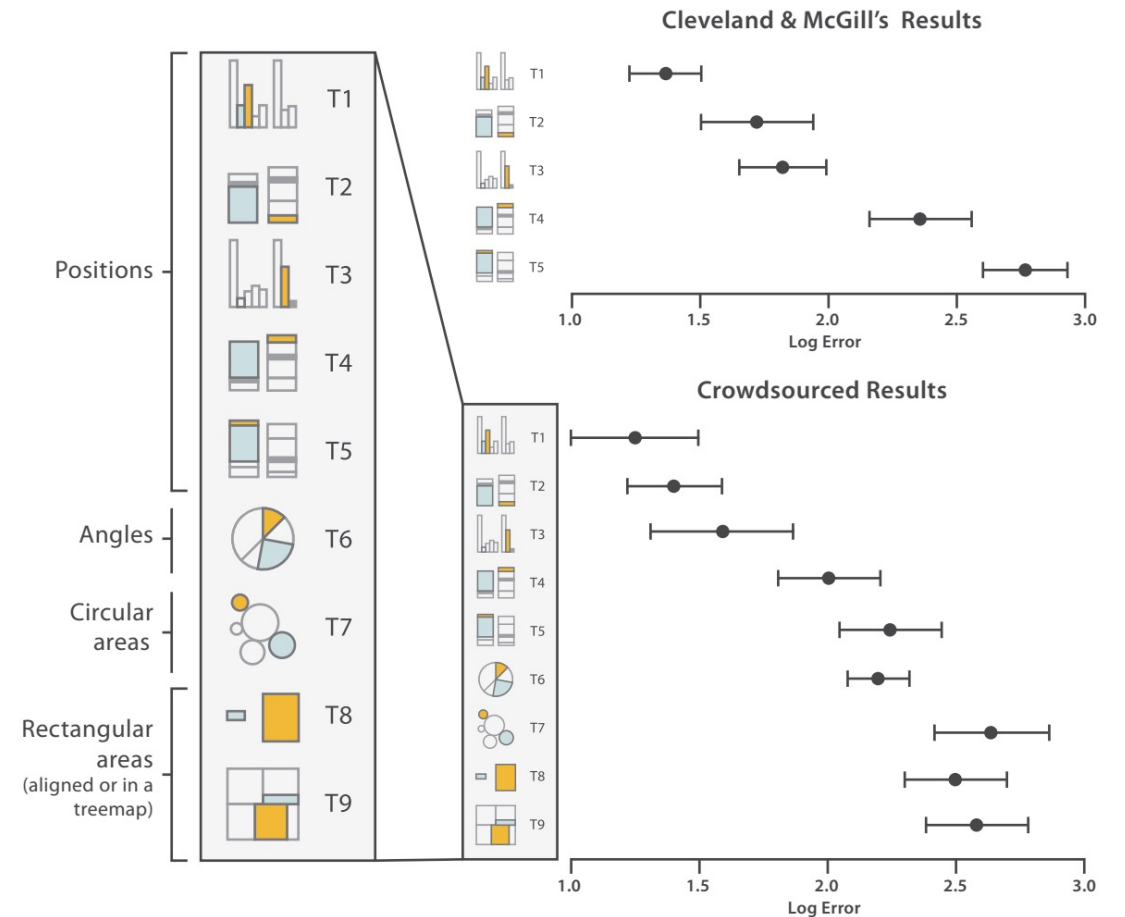
- S : Perceived Sensation
- I : Physical Intensity



Accuracy

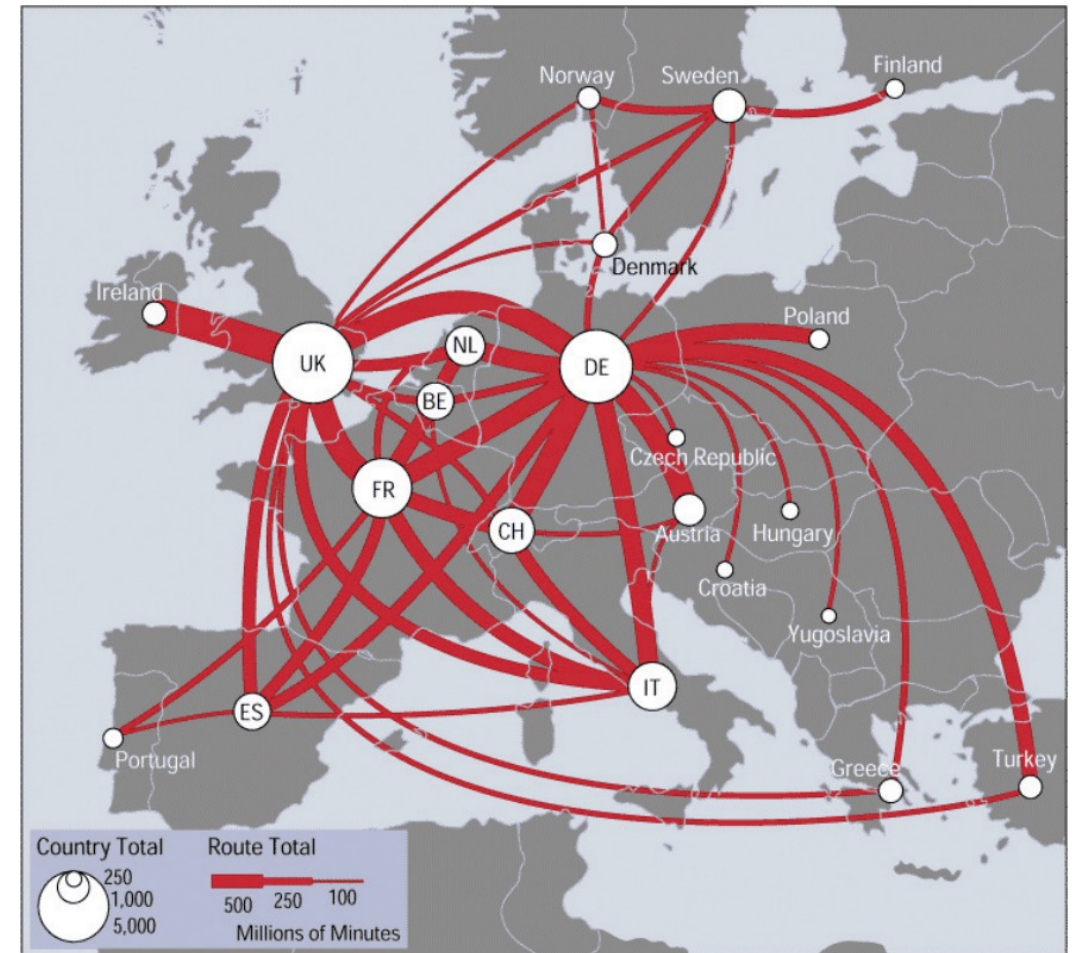
- **Error rates across visual channels**

- Cleveland & McGill's experiments
- Heer & Bostock's experiments
 - Extended by using crowdsourcing



Discriminability

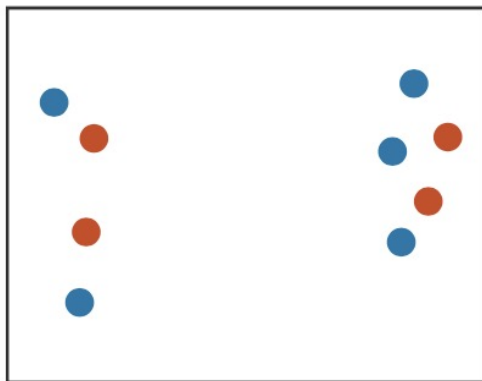
- **Distinguishable step or level from other**
 - The differences between items must be perceptible to the human as intended.
 - The characterization of visual channel should quantify the number of bins.



Separability

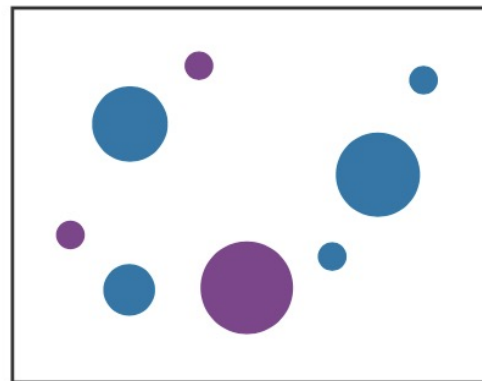
- **Separability vs. Integrality**

- Consider a continuum of potential interactions between channels for each pair, ranging from the orthogonal and independent separable channels to the inextricably combined integral channels.



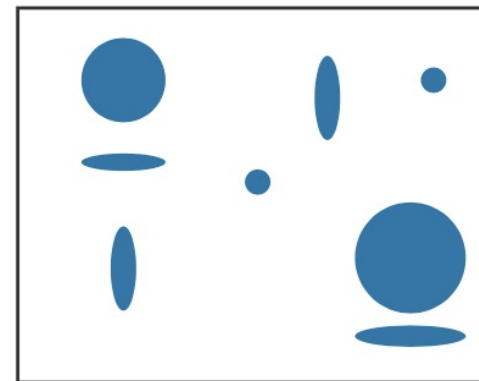
Position + Hue(Color)

Fully separable



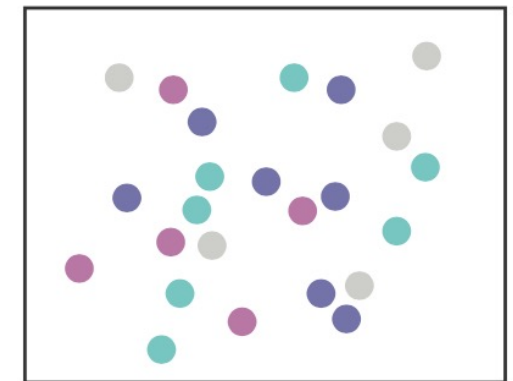
Size + Hue(Color)

Some interference



Width + Height

Significant interference



Red + Green

Major interference

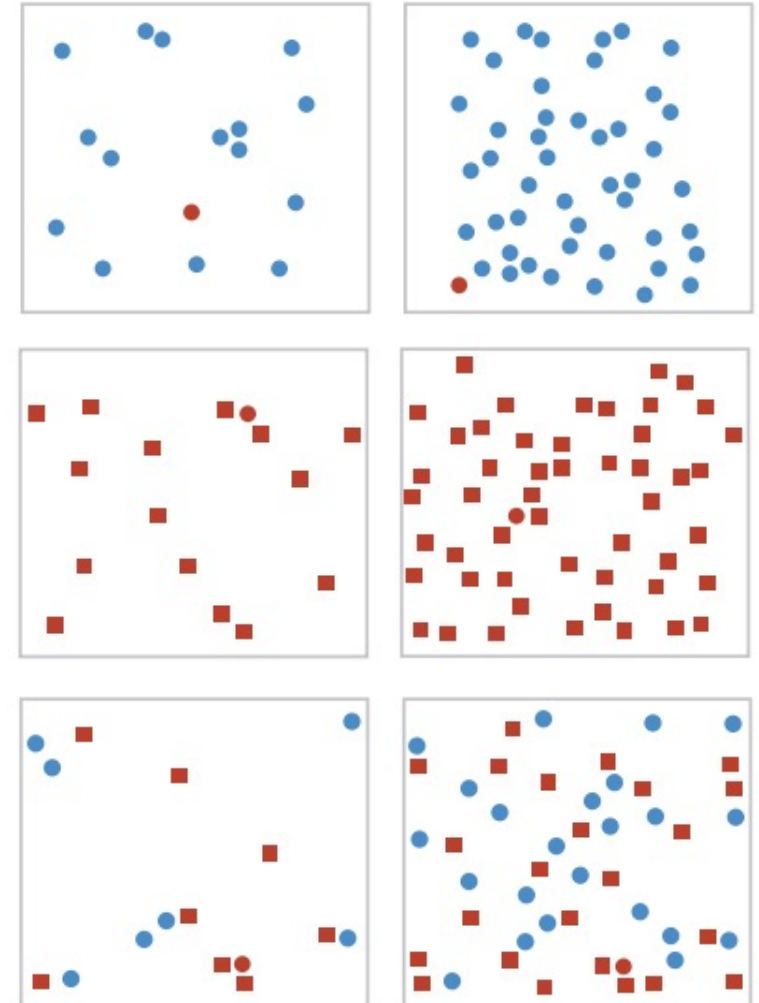
Popout

- **Visual Popout**

- A distinct item stands out from many others immediately
- Often called preattentive processing or tunable detection

- **Find the red circle**

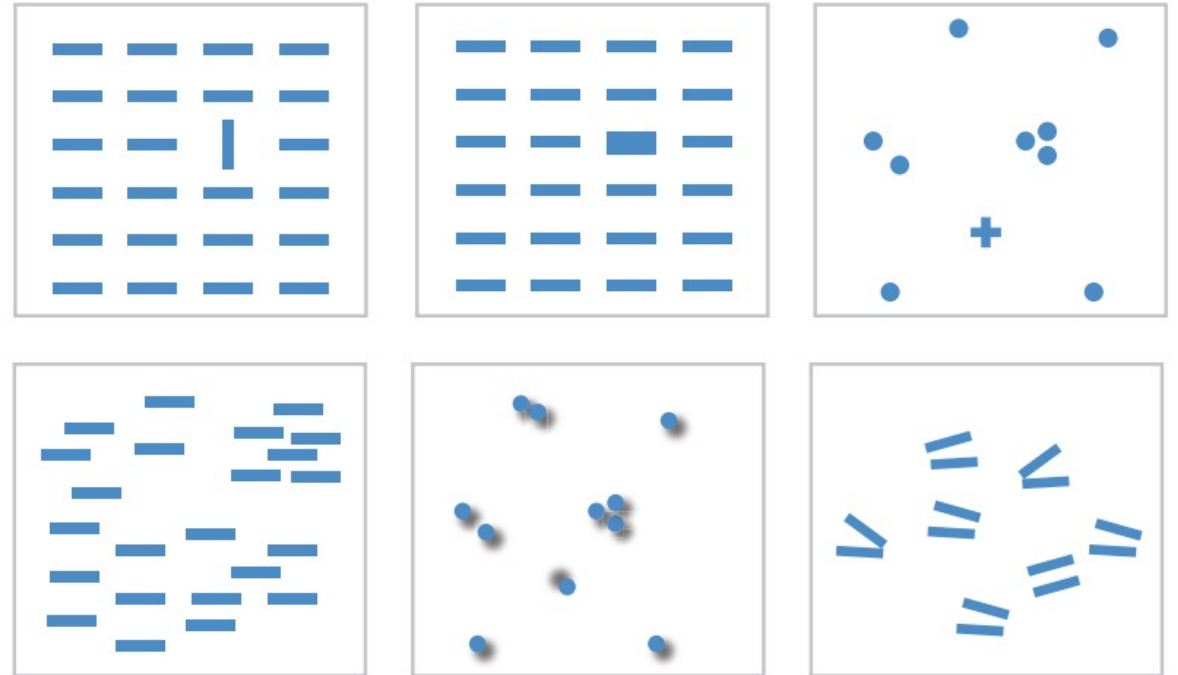
- Parallel processing on many individual channels
 - Speed independent of distractor count
 - Speed depends on channel and amount of difference from distractors
- Serial search for combinations
 - Speed depends on number of distractors



Popout

- **Visual Popout**

- Many channels support visual popout
 - Tilt, size, shape, proximity, shadow, ...
- But not all
 - Parallel line pairs



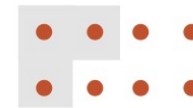
Grouping

- **Marks**

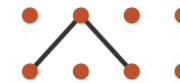
- Containment
- Connection

Marks as Links

➔ Containment



➔ Connection



- **Channels**

- Categorical attributes

➔ Identity Channels: Categorical Attributes

Spatial region



Color hue



Motion



Shape



Relative vs. Absolute Judgements

- **Weber's Law**

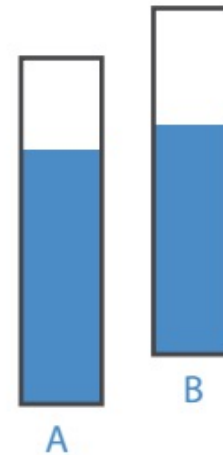
- Human perceptual system is fundamentally based on relative judgements, not absolute.

$$\frac{\delta I}{I} = K$$

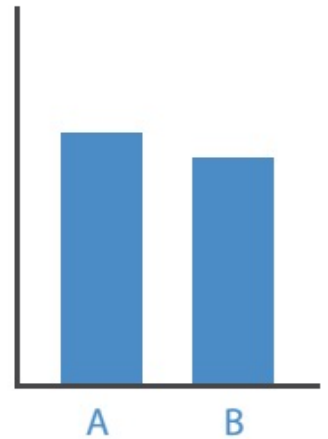
- I :Stimulus Intensity
- K :Constant



Unframed
Unaligned



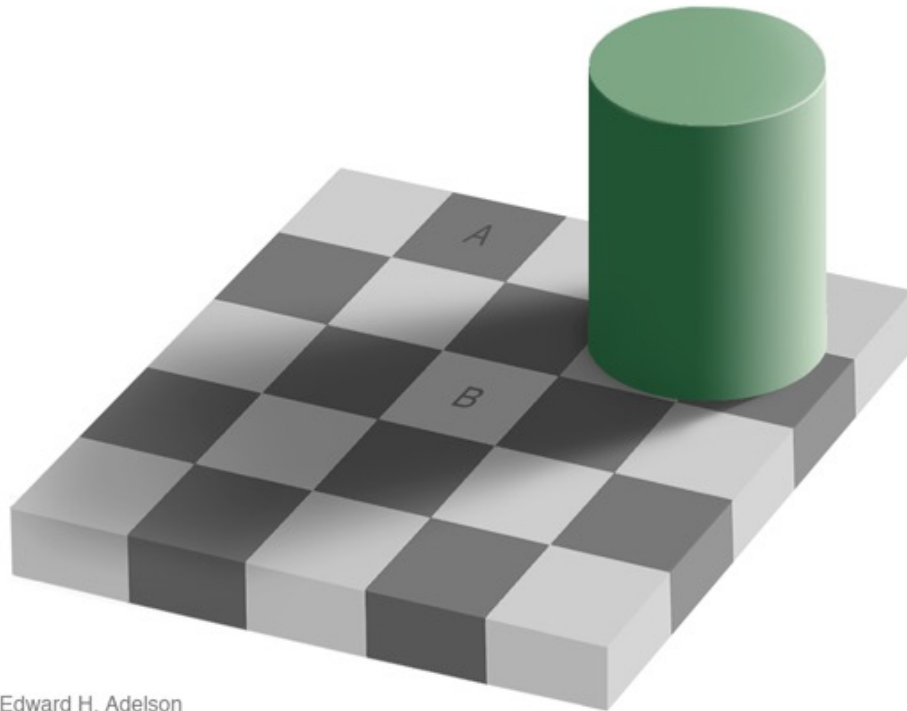
Framed
Unaligned



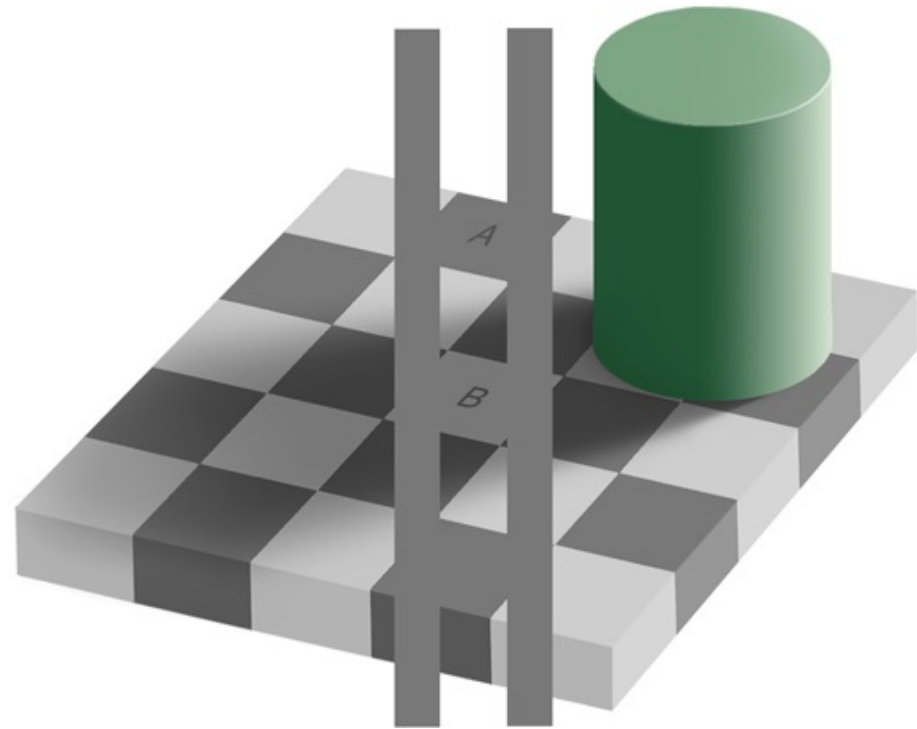
Unframed
Aligned

Relative vs. Absolute Judgements

- **Luminance Perception**
 - Based on relative, not absolute

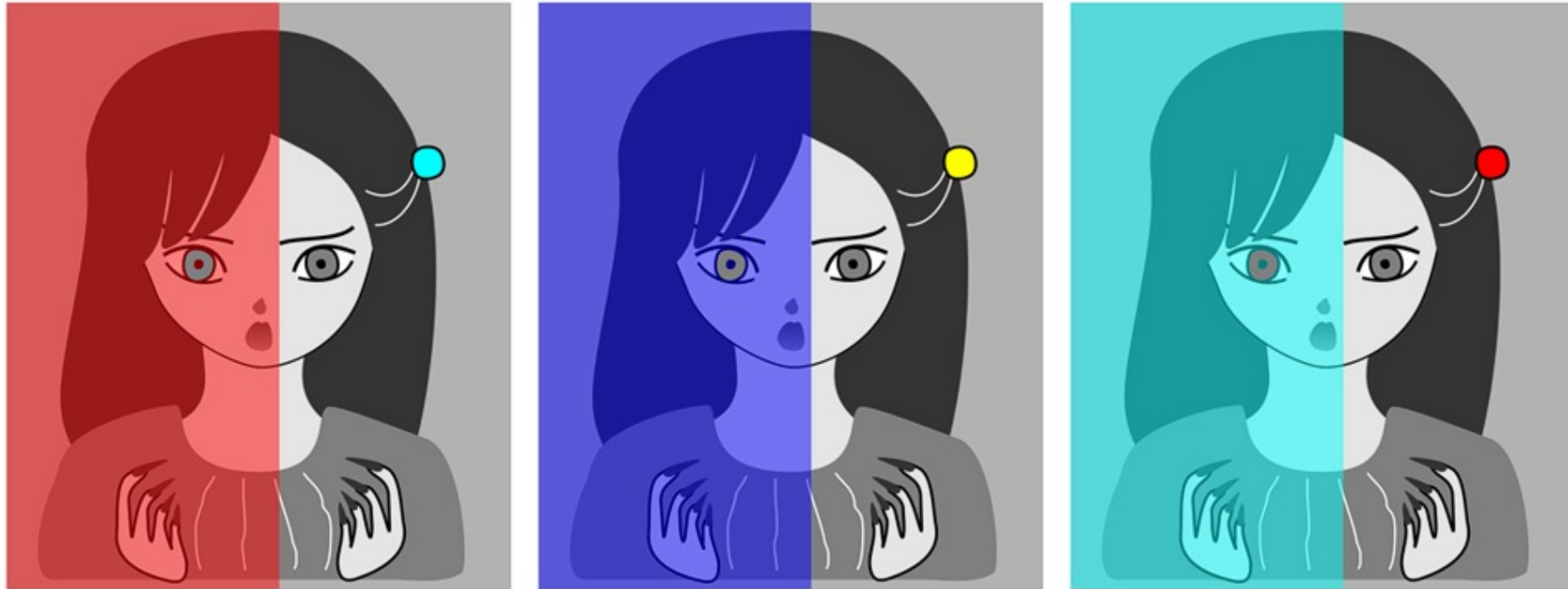


Edward H. Adelson



Relative vs. Absolute Judgements

- **Color Perception**
 - Relative to surrounding colors and depends on context



Polling

- **Take the poll**
 - Student ID Number
 - Name
 - Q1: Link to bad visualization
 - Q2: Explain why bad vis for Q1 in terms of marks and channels