Animation

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CS 448B: Visualization
Fall 2021

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Using Color in Visualization

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Colormap Design Considerations

1. Perceptually distinguishable colors
2. Value distance matches perceptual distance
3. Colors and concepts properly align
4. Aesthetically pleasing, intriguing
5. Respect color vision deficiencies
6. Should survive printing to black & white
7. Don’t overwhelm people’s capability!

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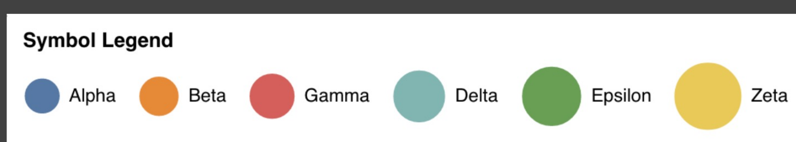
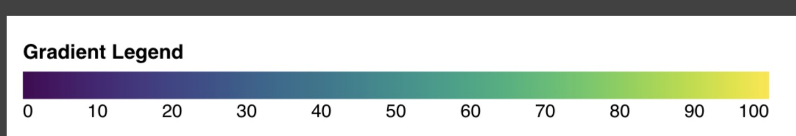
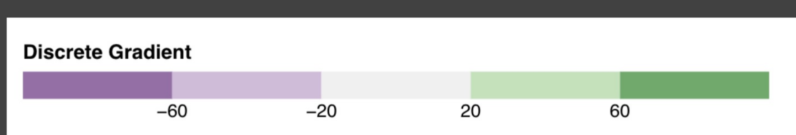
Discrete (Binary, Categorical)



Continuous (Sequential, Diverging, Cyclic)



Discretized Continuous



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Categorical Color

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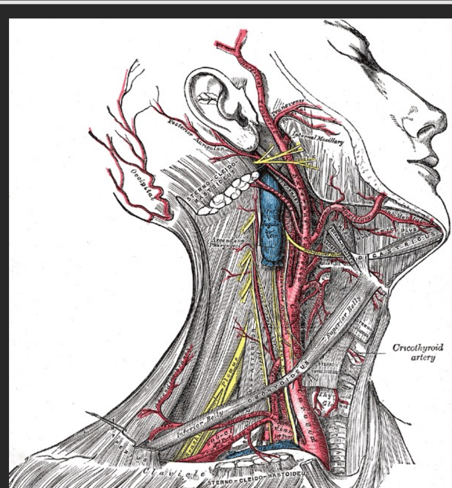
Gray' s Anatomy



Superficial dissection of the right side of the neck, showing the carotid and subclavian arteries
http://www.bartleby.com/107/illus520.html

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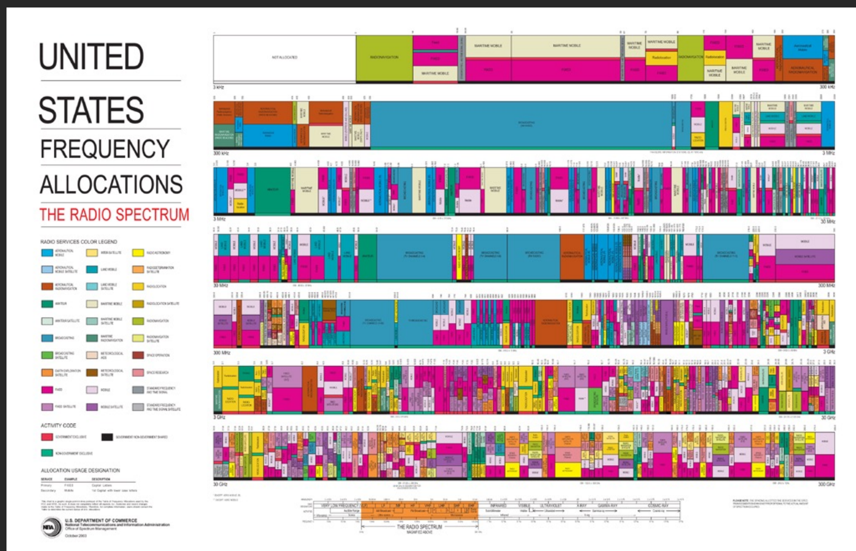
Radio Spectrum Map (33 colors)



http://www.cybergeography.org/atlas/us_spectrum_map.pdf

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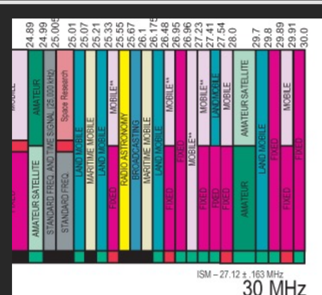
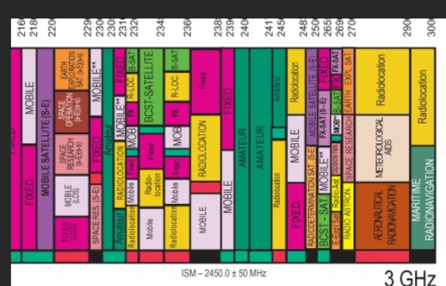
Issues





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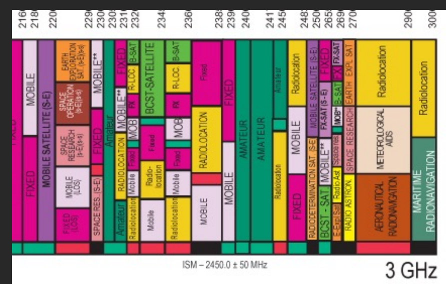
Issues

1. Too many colors
2. Hard to remember mapping
3. Colors not distinctive
4. Poor grouping; similar bands with dissimilar colors
5. Labels cause clutter
6. Color surround effects
7. Color interactions; adjacent colors don't look good next to each other



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Palette Design + Color Names

Minimize overlap and ambiguity of color names

Color Name Distance

										Salience	Name
0.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.20	.47	**blue** 62.9%
1.00	0.00	1.00	0.97	1.00	1.00	1.00	1.00	0.96	1.00	.90	**orange** 93.9%
1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.90	0.99	.67	**green** 79.8%
1.00	0.97	1.00	0.00	1.00	0.95	0.99	1.00	1.00	1.00	.66	**red** 80.4%
0.98	1.00	1.00	1.00	0.00	0.96	0.91	0.97	1.00	0.99	.47	**purple** 51.4%
1.00	1.00	1.00	0.95	0.96	0.00	0.97	0.93	0.98	1.00	.37	**brown** 54.0%
1.00	1.00	1.00	0.99	0.91	0.97	0.00	1.00	1.00	1.00	.58	**pink** 71.7%
1.00	1.00	1.00	1.00	0.97	0.93	1.00	0.00	1.00	1.00	.67	**grey** 79.4%
1.00	0.96	0.90	1.00	1.00	0.98	1.00	1.00	0.00	1.00	.18	**yellow** 31.2%
0.20	1.00	0.99	1.00	0.99	1.00	1.00	1.00	1.00	0.00	.25	**blue** 25.4%
Tableau-10								*Average*	*0.97*	.52	

http://vis.stanford.edu/color-names

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Palette Design + Color Names

Minimize overlap and ambiguity of color names

Color Name Distance

										Salience	Name
0.00	1.00	1.00	0.89	0.07	1.00	0.35	0.99	1.00	0.89	.30	**blue** 50.5%
1.00	0.00	0.99	1.00	1.00	0.92	1.00	0.84	0.98	0.99	.21	**red** 27.8%
1.00	0.99	0.00	1.00	0.98	1.00	1.00	1.00	0.17	1.00	.34	**green** 36.8%
0.89	1.00	1.00	0.00	0.98	1.00	0.71	0.93	1.00	0.32	.55	**purple** 67.3%
0.07	1.00	0.98	0.98	0.00	1.00	0.36	1.00	0.97	0.95	.20	**blue** 36.6%
1.00	0.92	1.00	1.00	1.00	0.00	1.00	0.97	0.99	1.00	.39	**orange** 51.9%
0.35	1.00	1.00	0.71	0.36	1.00	0.00	0.95	0.92	0.42	.13	**blue** 15.7%
0.99	0.84	1.00	0.93	1.00	0.97	0.95	0.00	0.98	0.85	.16	**pink** 29.4%
1.00	0.98	0.17	1.00	0.97	0.99	0.92	0.98	0.00	0.97	.12	**green** 21.7%
0.89	0.99	1.00	0.32	0.95	1.00	0.42	0.85	0.97	0.00	.30	**purple** 23.9%
Excel-10								*Average*	*0.87*	*.27*	

http://vis.stanford.edu/color-names

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Quantitative Color

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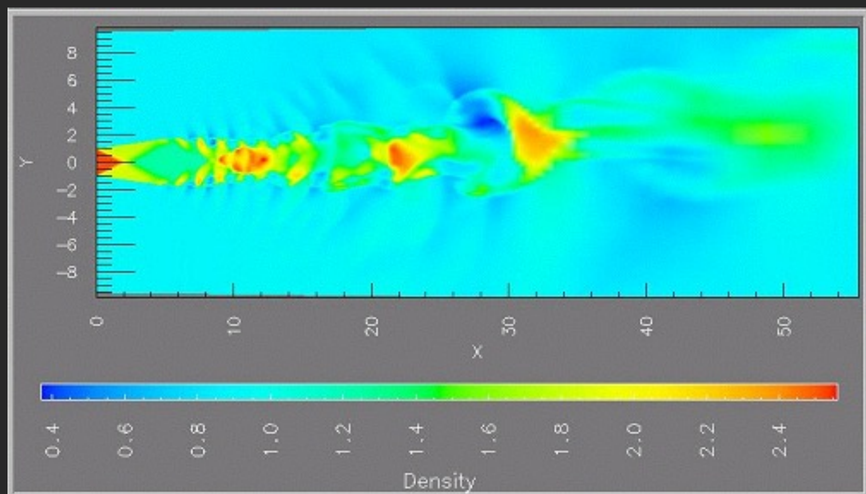
Mapping Data to Color (Rainbows)



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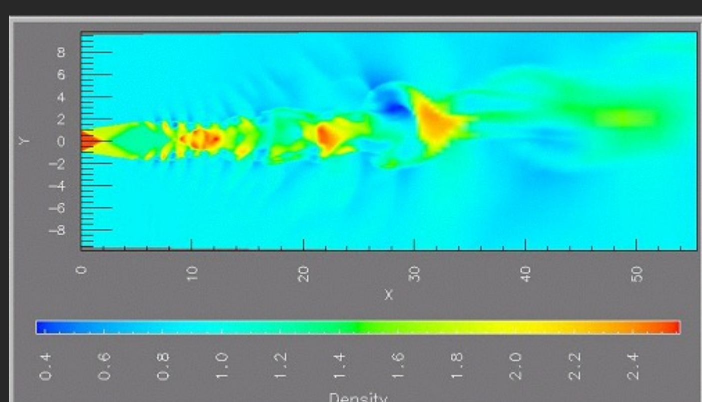
Avoid rainbow color maps!



1. Hues are not naturally ordered
2. People segment colors into classes, perceptual banding
3. Naïve rainbows unfriendly to color blind viewers
4. Low luminance colors (blue) hide high frequencies

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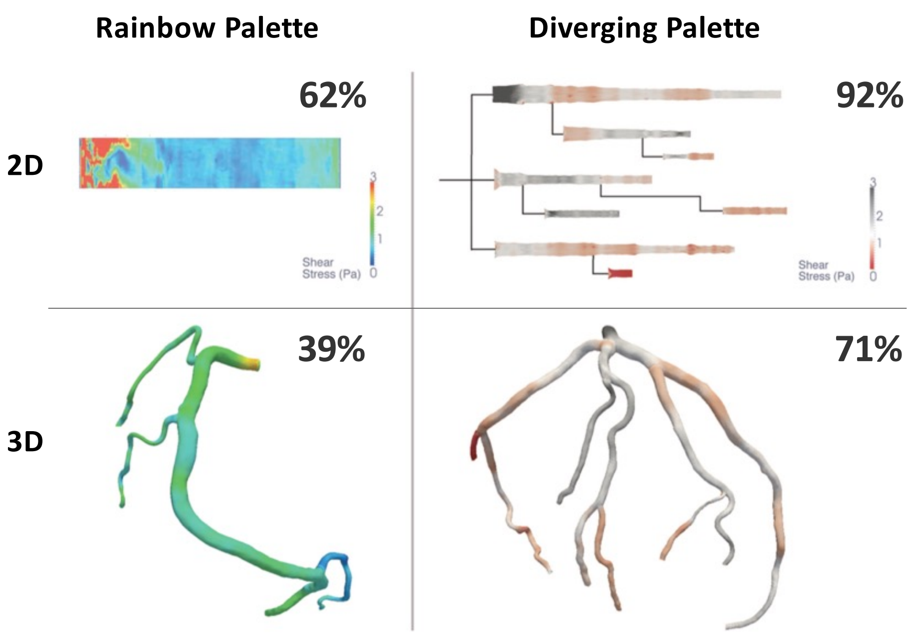
Artery Visualization [Borkin et al '11]



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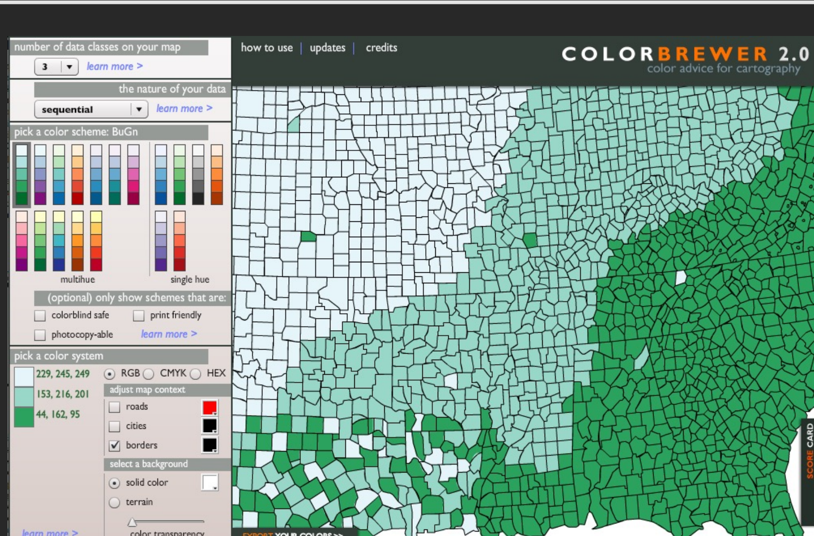
Steps, rather than gradients



www.colorbrewer2.org

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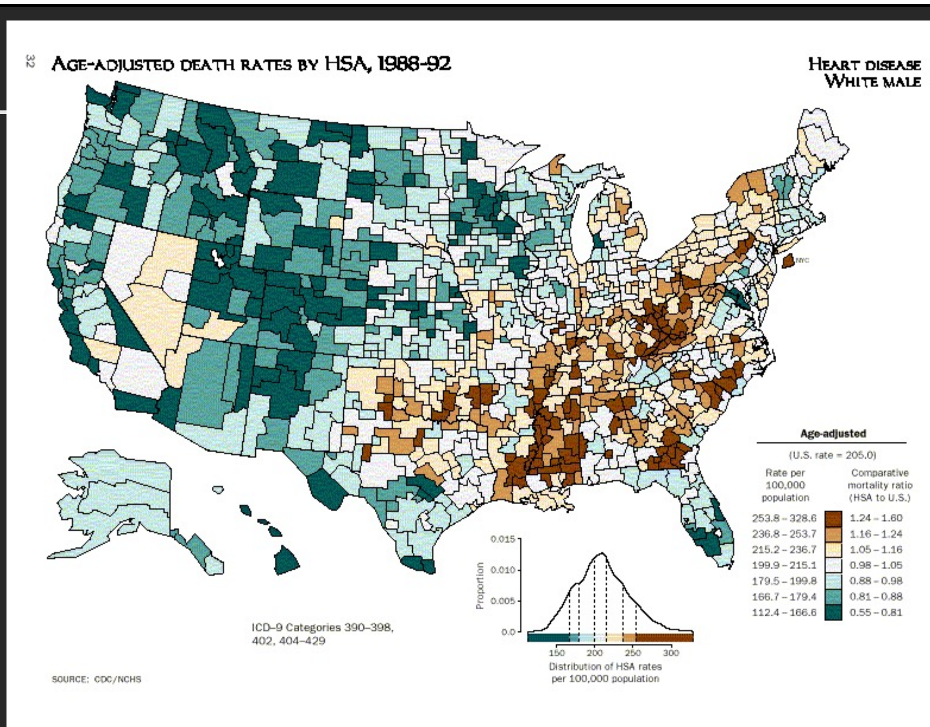

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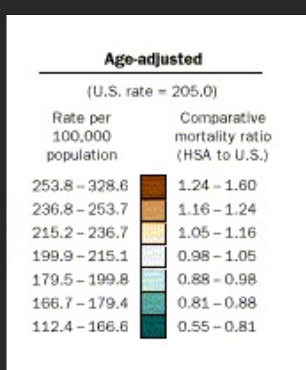
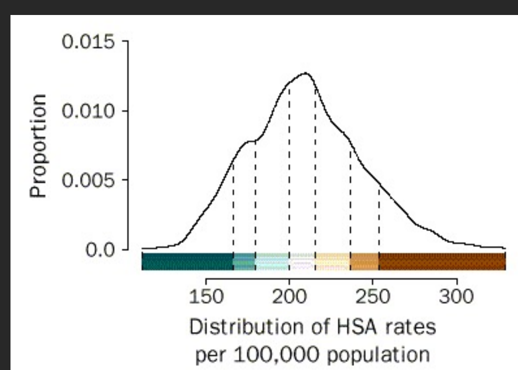
Classing quantitative data





Age-adjusted mortality rates for the United States

Common option: break into 5 or 7 quantiles

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Classing Quantitative Data

Equal interval (arithmetic progression)
Quantiles *(recommended)*
Standard deviations
Clustering (Jenks' natural breaks / 1D K-Means)
- Minimize within group variance
- Maximize between group variance

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Quantitative color encoding

Sequential color scale
- Ramp in luminance, possibly also hue
- Typically higher values map to darker colors

Diverging color scale
- Useful when data has a meaningful "midpoint"
- Use neutral color (e.g., grey) for midpoint
- Use saturated colors for endpoints

Limit number of steps in color to 3-9

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Summary

Color perception

- Better acuity for luminance than for hue
- Beware of simultaneous contrast, crispening, spreading

Color naming

- Use colors that are easily distinguished by name

Color palettes

- Use small number of hues (about 6)
- Avoid rainbow palette except in special cases
- Steal well designed palettes (e.g. ColorBrewer)
- Consider sequential and diverging scales for Q data

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Announcements

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Final project

Data analysis/explainer or conduct research

- **Data analysis**: Analyze dataset in depth & make a visual explainer
- **Research**: Pose problem, Implement creative solution

Deliverables

- **Data analysis/explainer**: Article with multiple different interactive visualizations
- **Research**: Implementation of solution and web-based demo if possible
- **Short video (2 min)** demoing and explaining the project

Schedule

- Project proposal: Wed 11/3
- Design Review and Feedback: 10th week of quarter
- Final code and video: Fri 12/10 11:59pm

Grading

- Groups of up to 3 people, graded individually
- Clearly report responsibilities of each member

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Animation

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Question

The goal of visualization is to convey information

How does *animation* help convey information?

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Cone Trees [Robertson 91]

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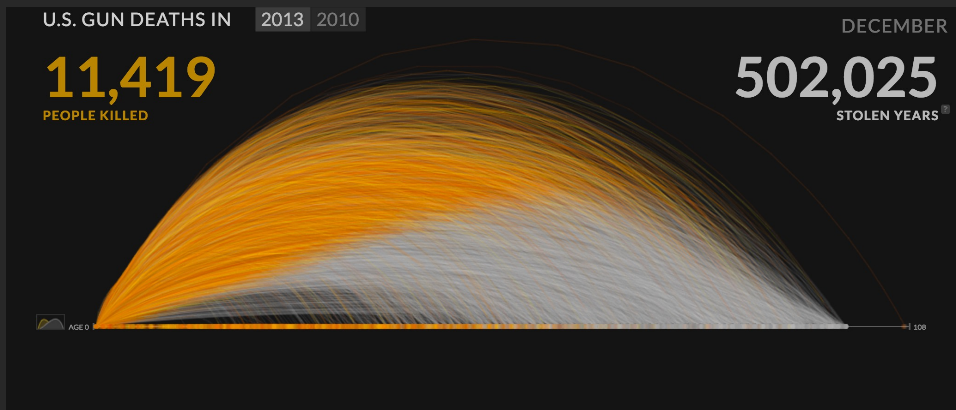
U.S. Gun Deaths [Periscopic 2013]



http://guns.periscopic.com/?year=2013

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Why Use Motion?

Visual variable to encode data
Direct attention
Understand system dynamics
Understand state transition
Increase engagement

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Topics

Understanding motion
Animated transitions in visualization
Implementing animation

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Understanding Motion

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Motion as a visual cue

Pre-attentive

- Stronger than color, shape, …

Triggers an orientation response

Motion parallax provides 3D cue

More sensitive to motion at periphery

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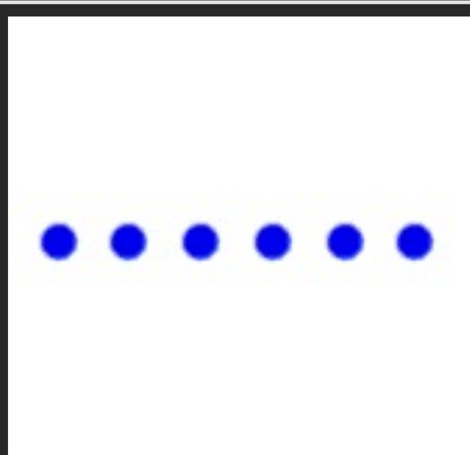
Grouped dots count as 1 object



Dots moving together are grouped

http://coe.sdsu.edu/eet/articles/visualperc1/start.htm

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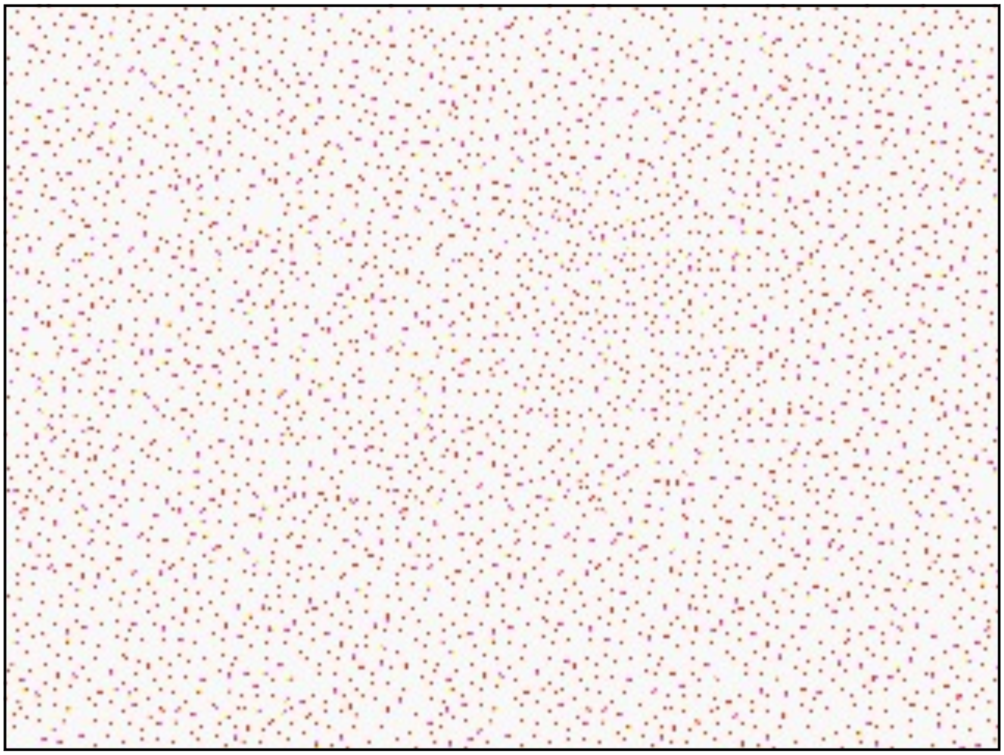

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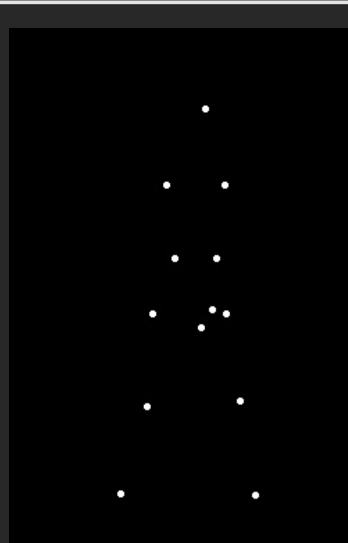
Grouping based on biological motion



[Johansson 73]

http://www.lifesci.sussex.ac.uk/home/George_Mather/Motion/

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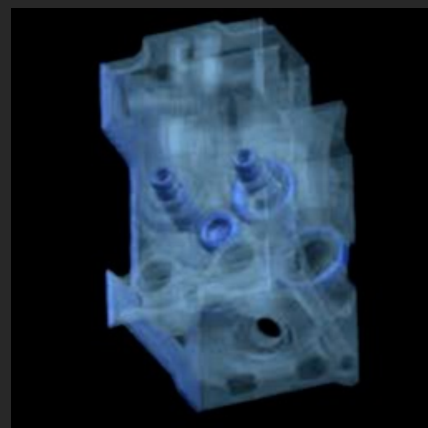
Volume rendering [Lacroute 95]



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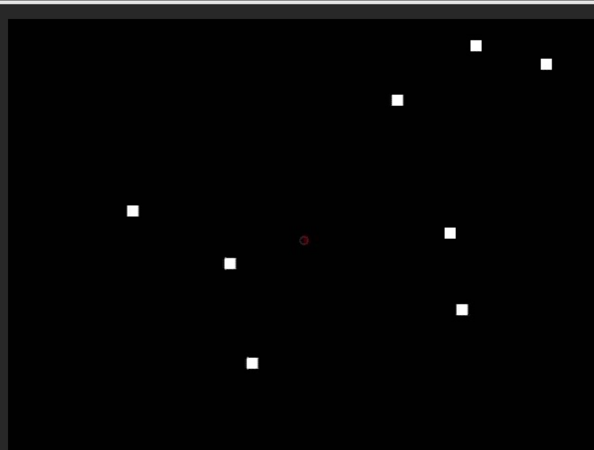
Tracking multiple targets



How many dots can we simultaneously track?

[Yantis 92, Pylyshn 88, Cavanagh 05]

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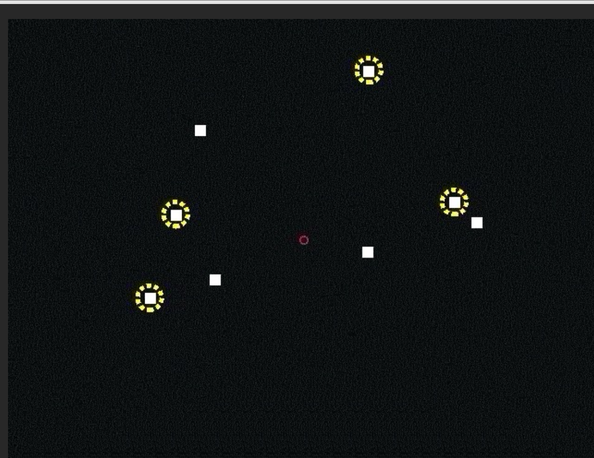
Tracking multiple targets



How many dots can we simultaneously track?

[Yantis 92, Pylyshn 88, Cavanagh 05]

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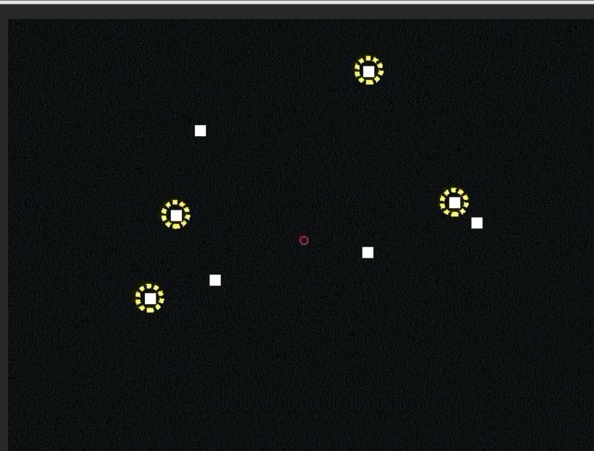
Tracking multiple targets



How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

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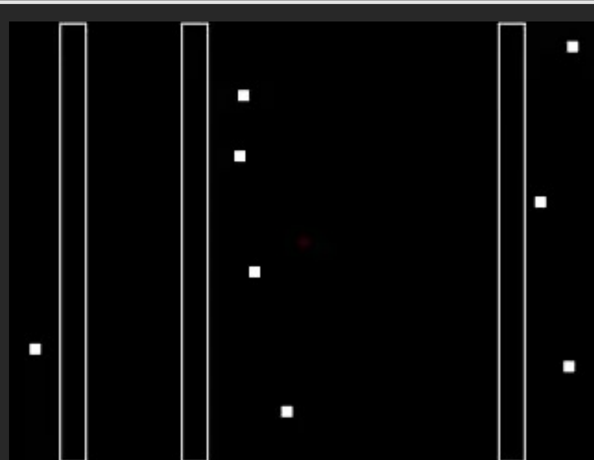
Tracking multiple targets



How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

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Tracking multiple targets

How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

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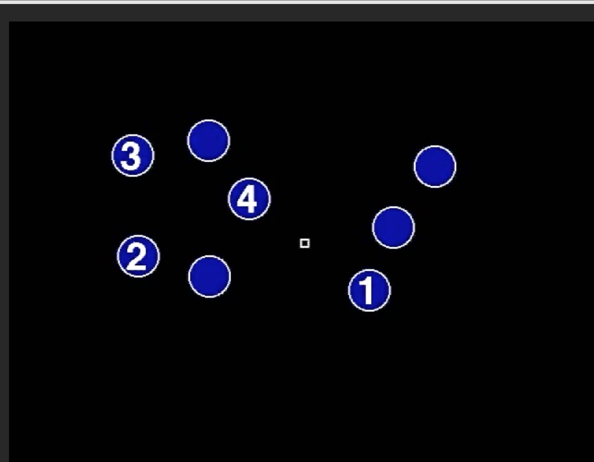
Tracking multiple targets



How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

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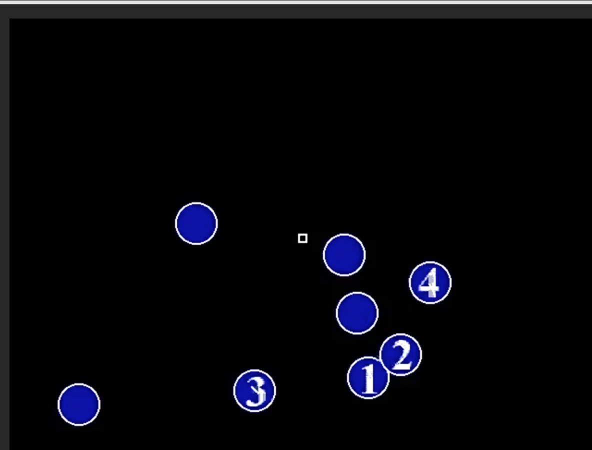
Tracking multiple targets



How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

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Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (mostly translations)

start

87

Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (mostly translations)

end

88

Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (translation, rotation, scale)

start **end**

Shows transition better, but

- Still may be too fast, or too slow
- Too many objects may move at once

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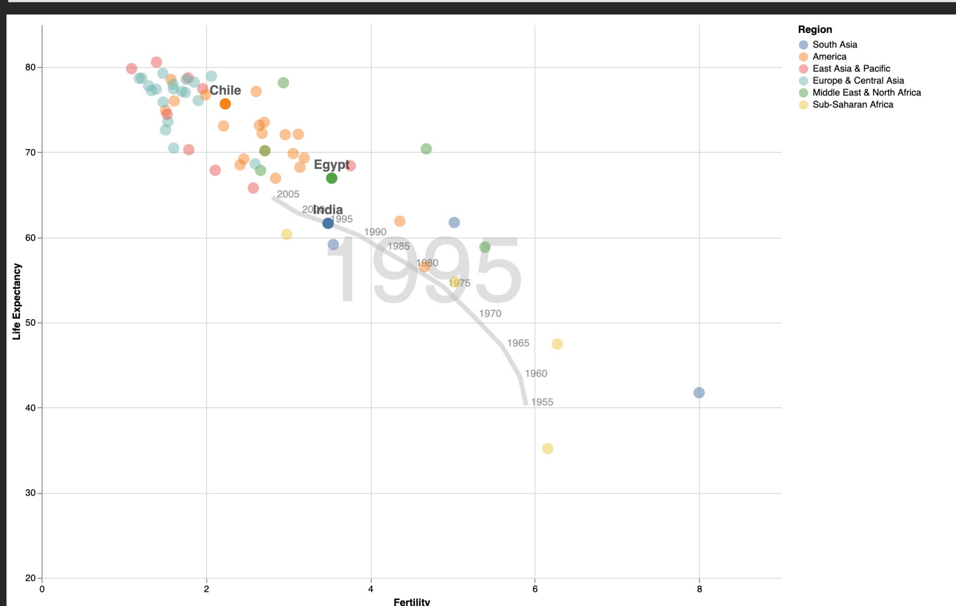
DimpVis [Kondo 14]



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Constructing narratives

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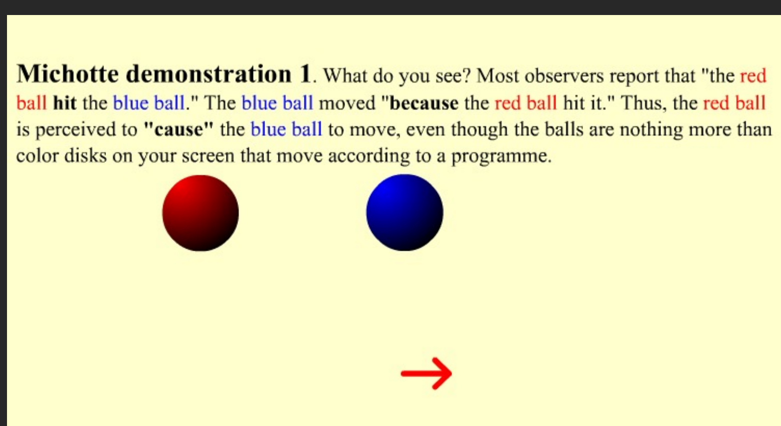
Attribution of causality [Michotte 46]



http://cogweb.ucla.edu/Discourse/Narrative/Heider_45.html

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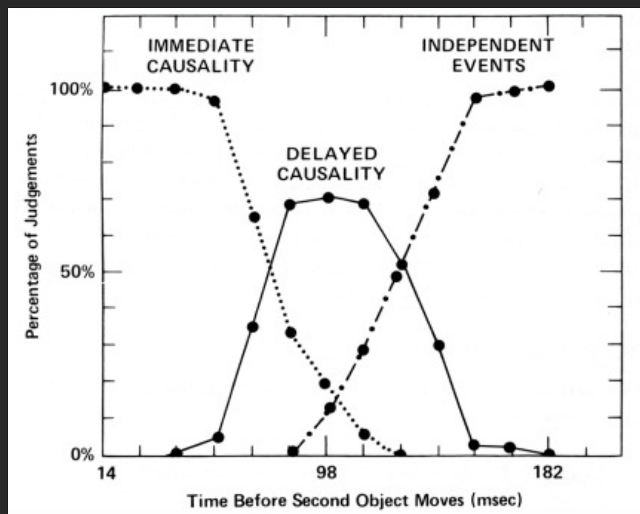
Attribution of causality [Michotte 46]



[Reprint from Ware 04]

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