

Perception and Color in Data Visualization

CPS 563 – Data Visualization

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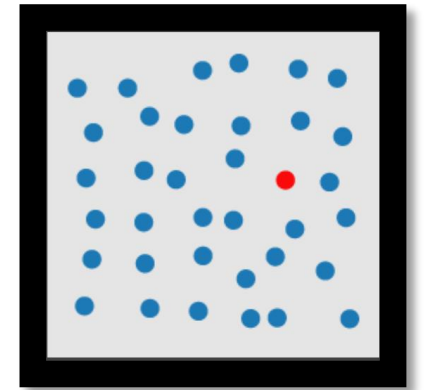
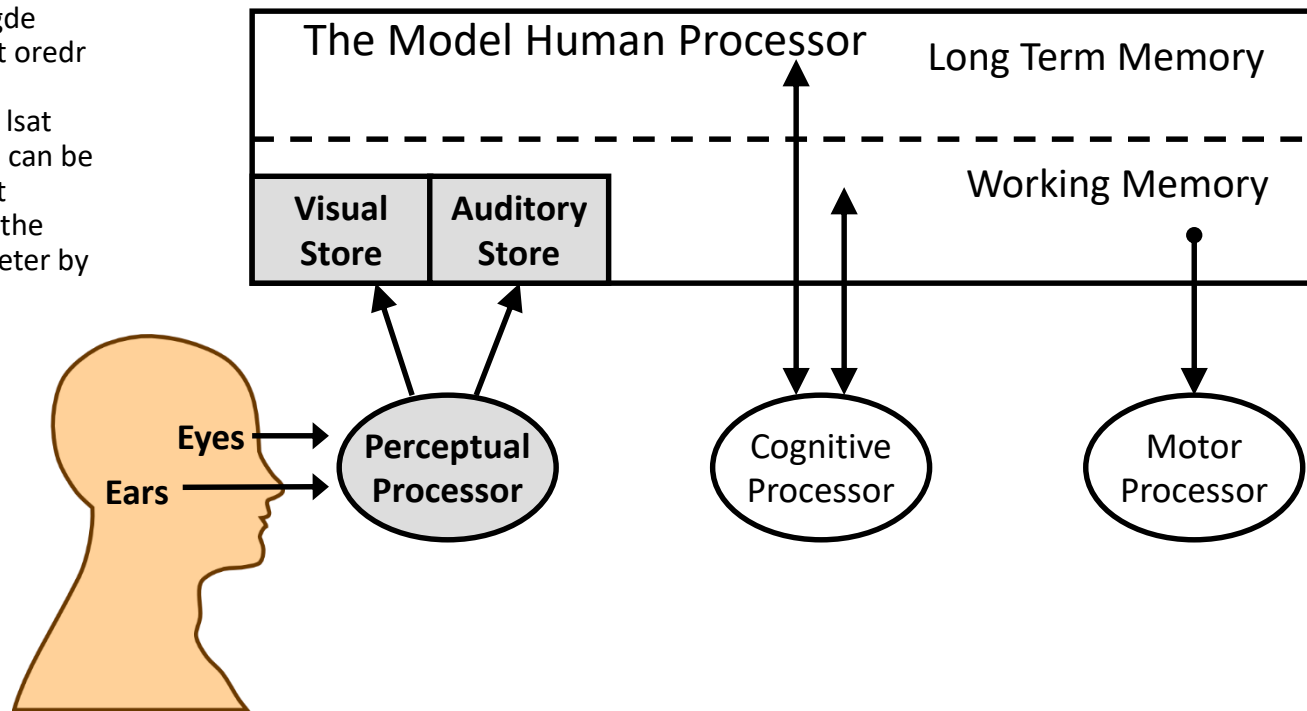
Outline

- Human Perceptual System
- Pre-Attentive Processing
- Color in Data Visualization

Perceptual System

- Responsible for transforming external environment into a form that cognitive system can process
- Composed of *perceptual memory* and *processor*

According to research at Cambridge University, it doesn't matter in what order the letters in a word are, the only important thing is that the first and last letter be at the right place. The rest can be a total mess and you can still read it without a problem. This is because the human mind does not read every letter by itself, but the word as a whole.



Visual Processing

- According to research at Cambridge University, it doesn't matter in what order the letters in a word are, the only important thing is that the first and last letter be at the right place. The rest can be a total mess and you can still read it without a problem. This is because the human mind does not read every letter by itself, but the word as a whole.

Visual Processing

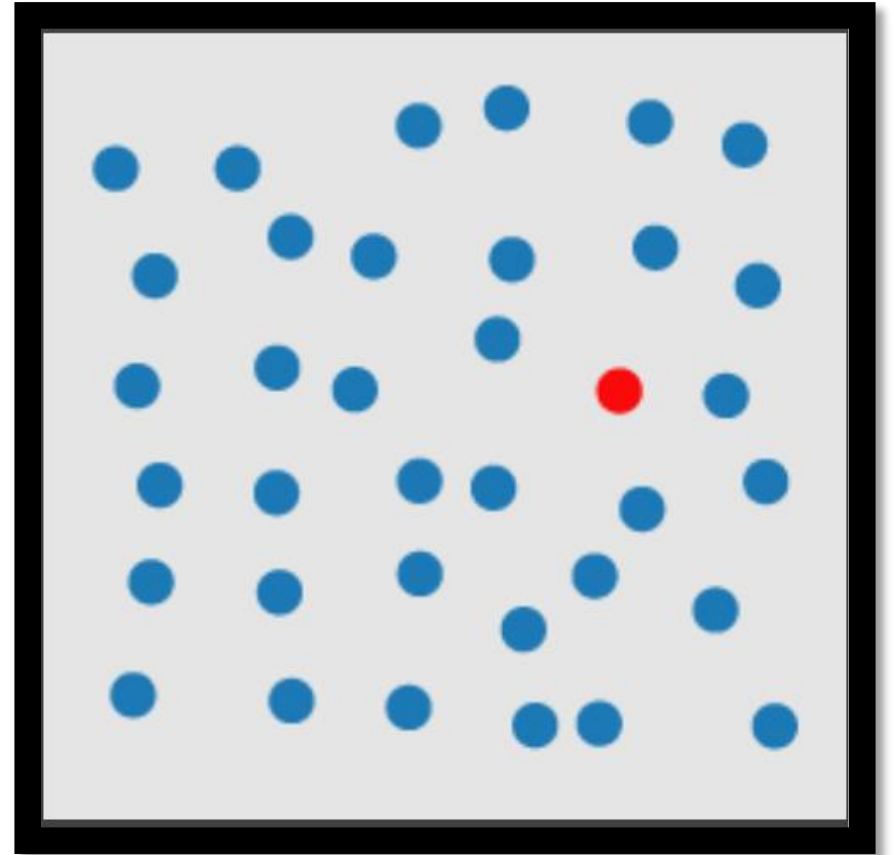
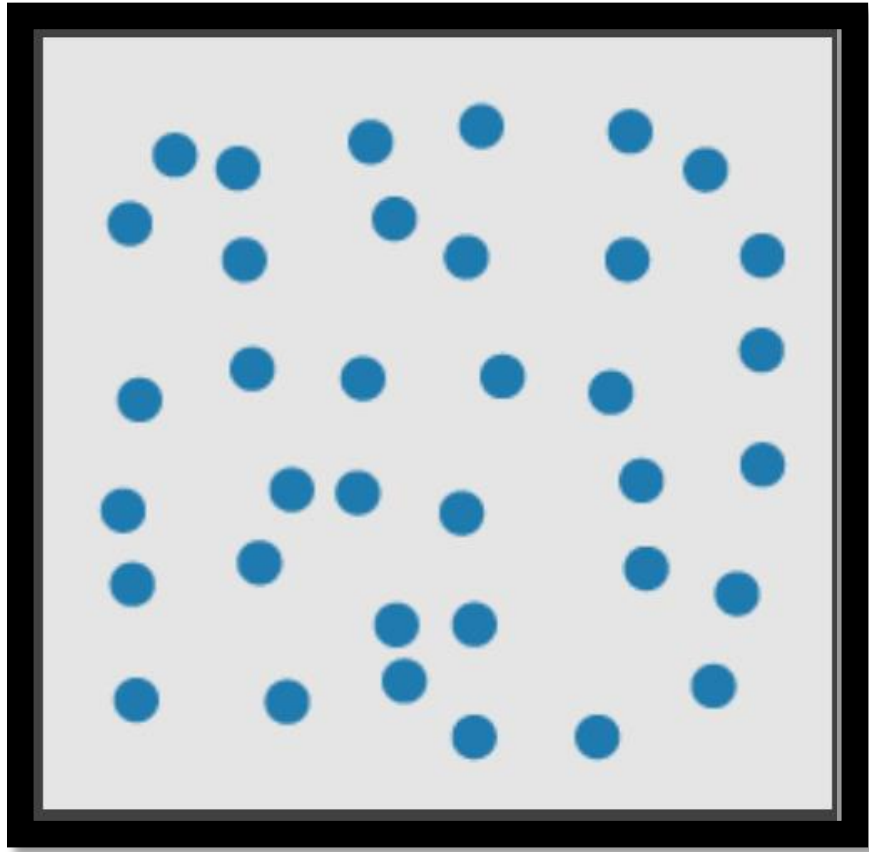
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9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

How many 3s?

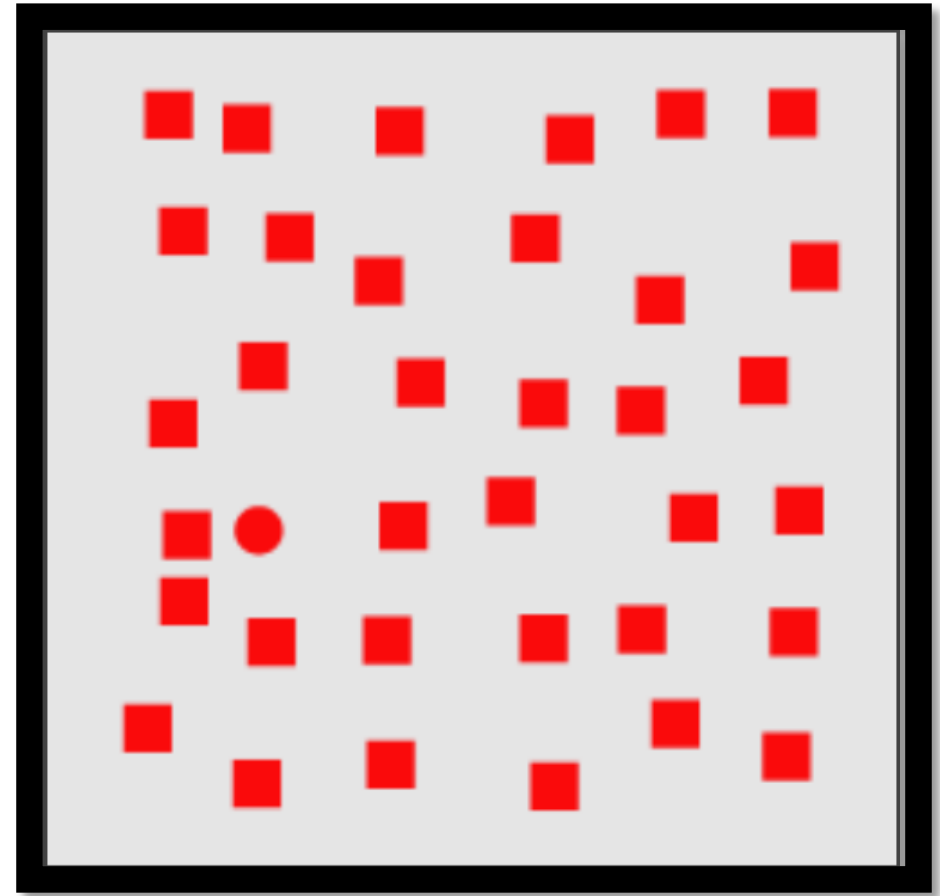
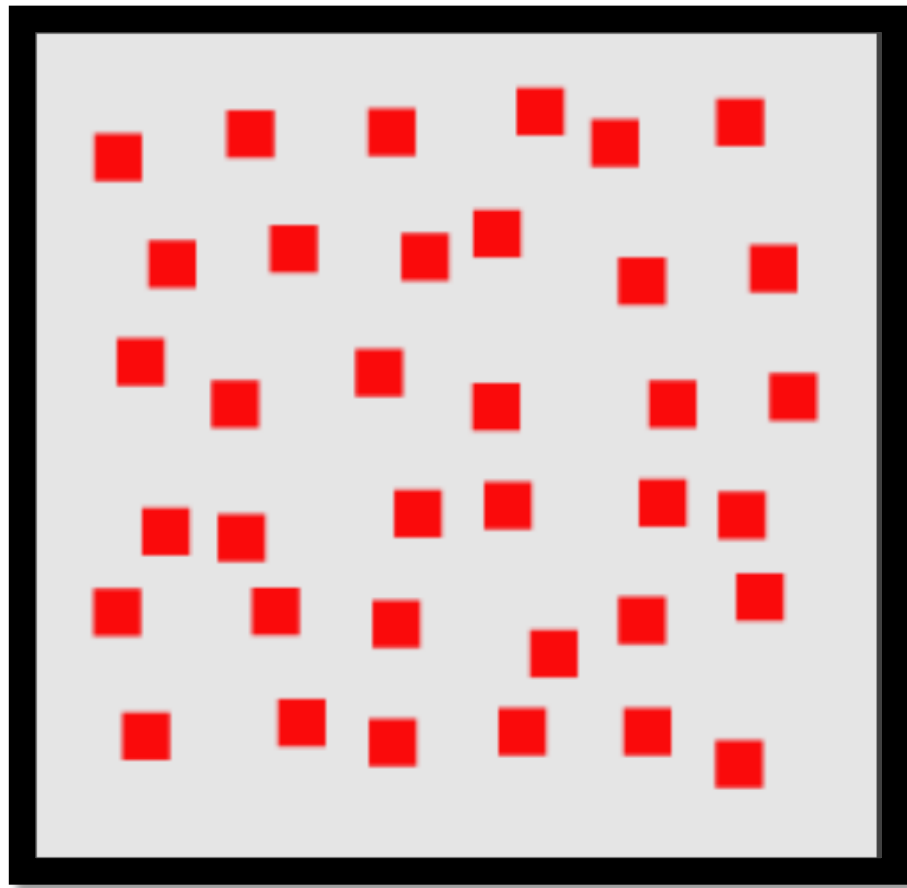
Visual Processing

1281768756138976546984506985604982826762
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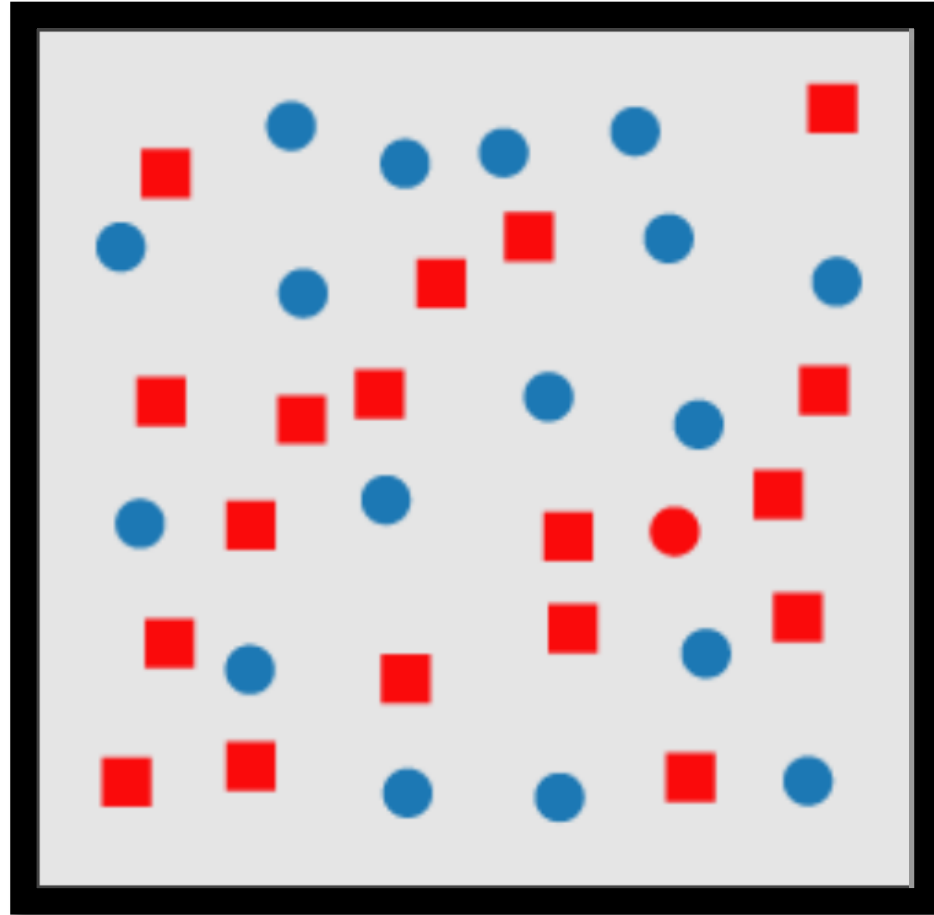
Visual Pop-Out: Color



Visual Pop-Out: Shape

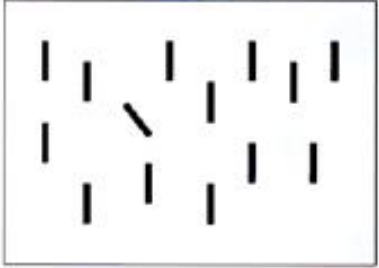


Feature Conjunctions



Pre-attentive features

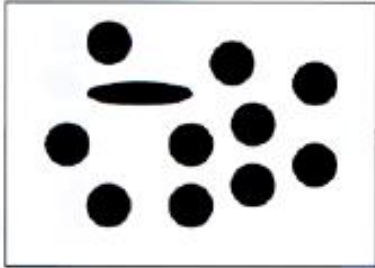
Orientation



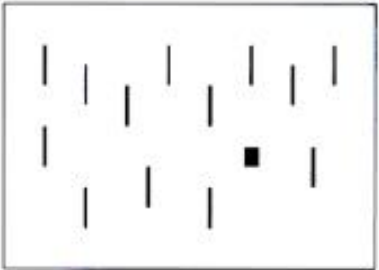
Curved/straight



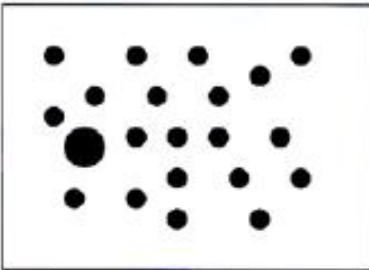
Shape



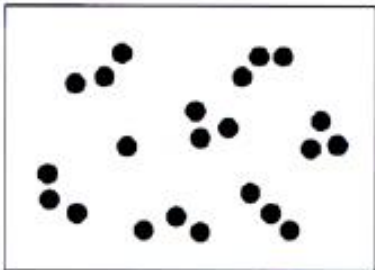
Shape



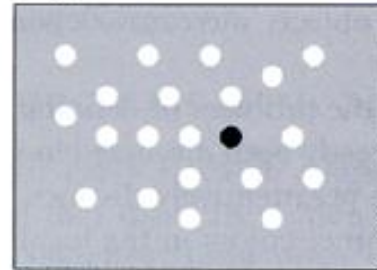
Size



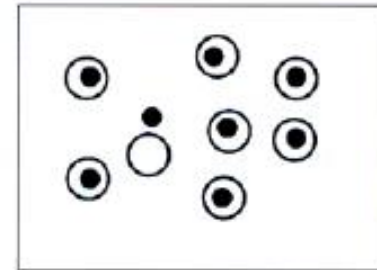
Number



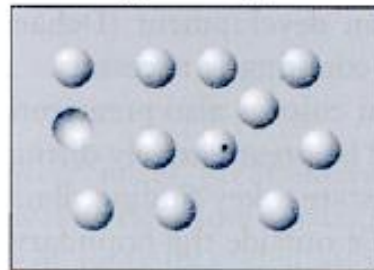
Gray/value



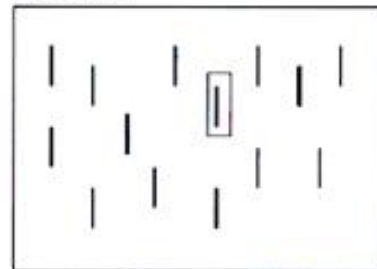
Enclosure



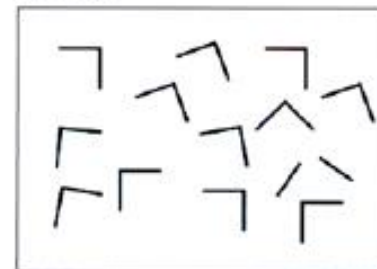
Convexity/concavity



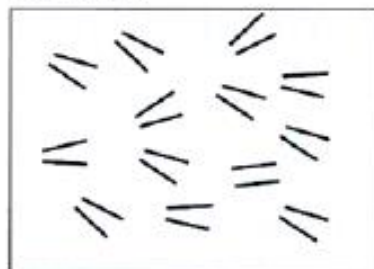
Addition



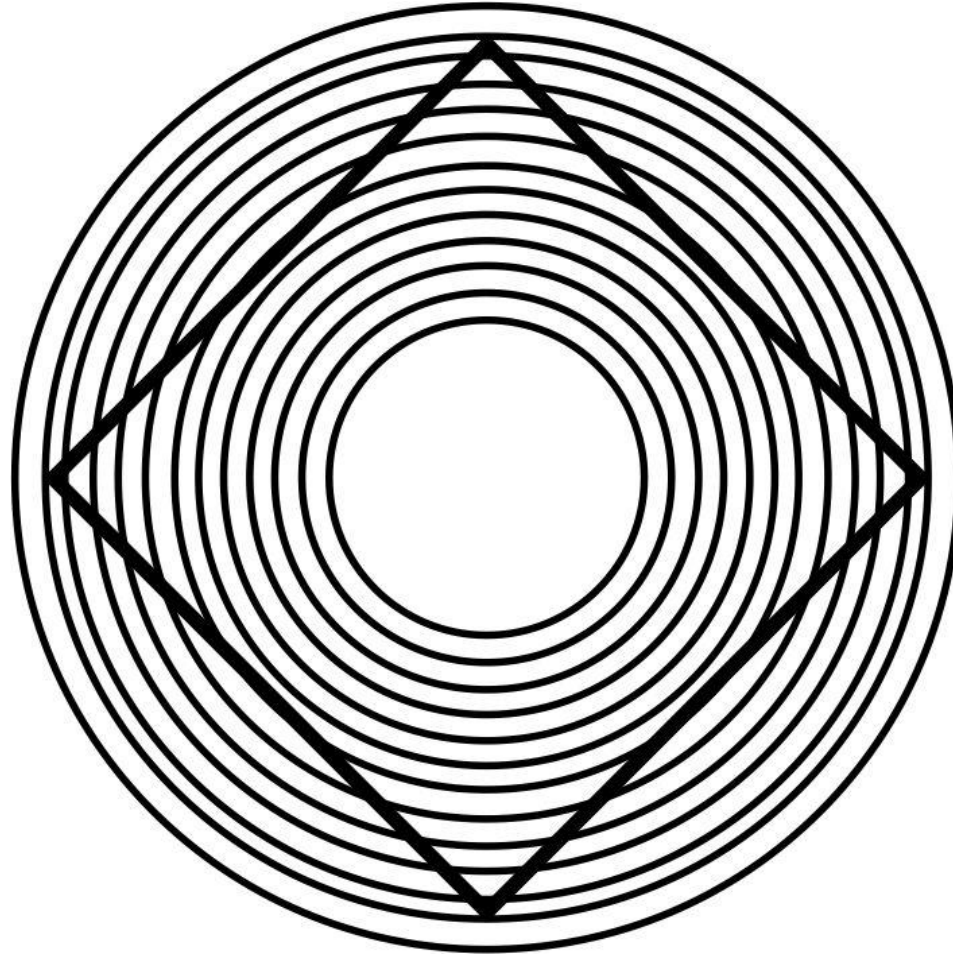
Juncture



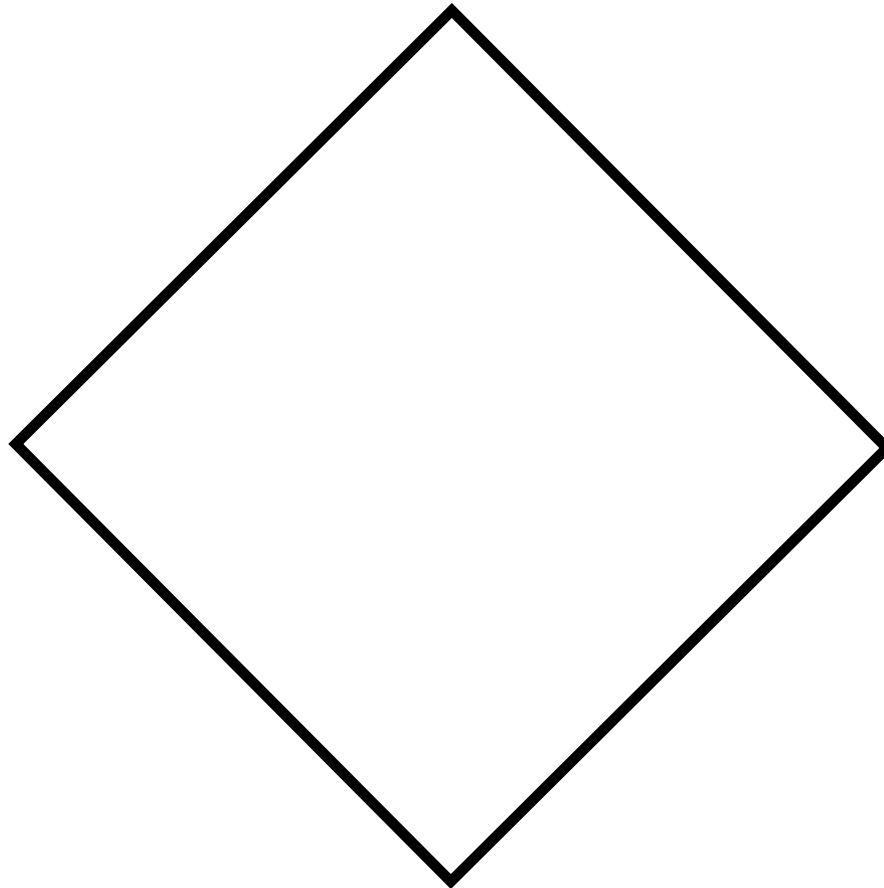
Parallelism



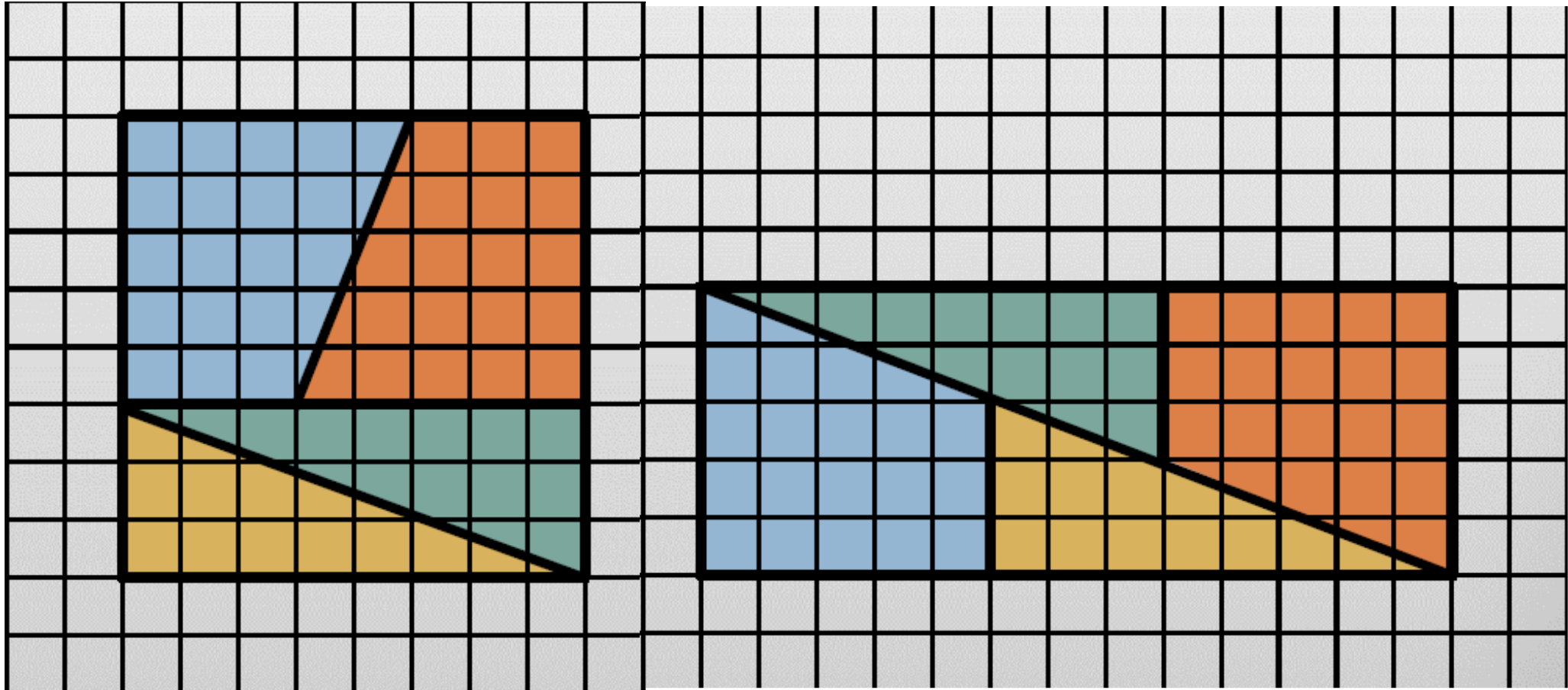
Human perception: Is what we see what we get?



Is what we see what we get?

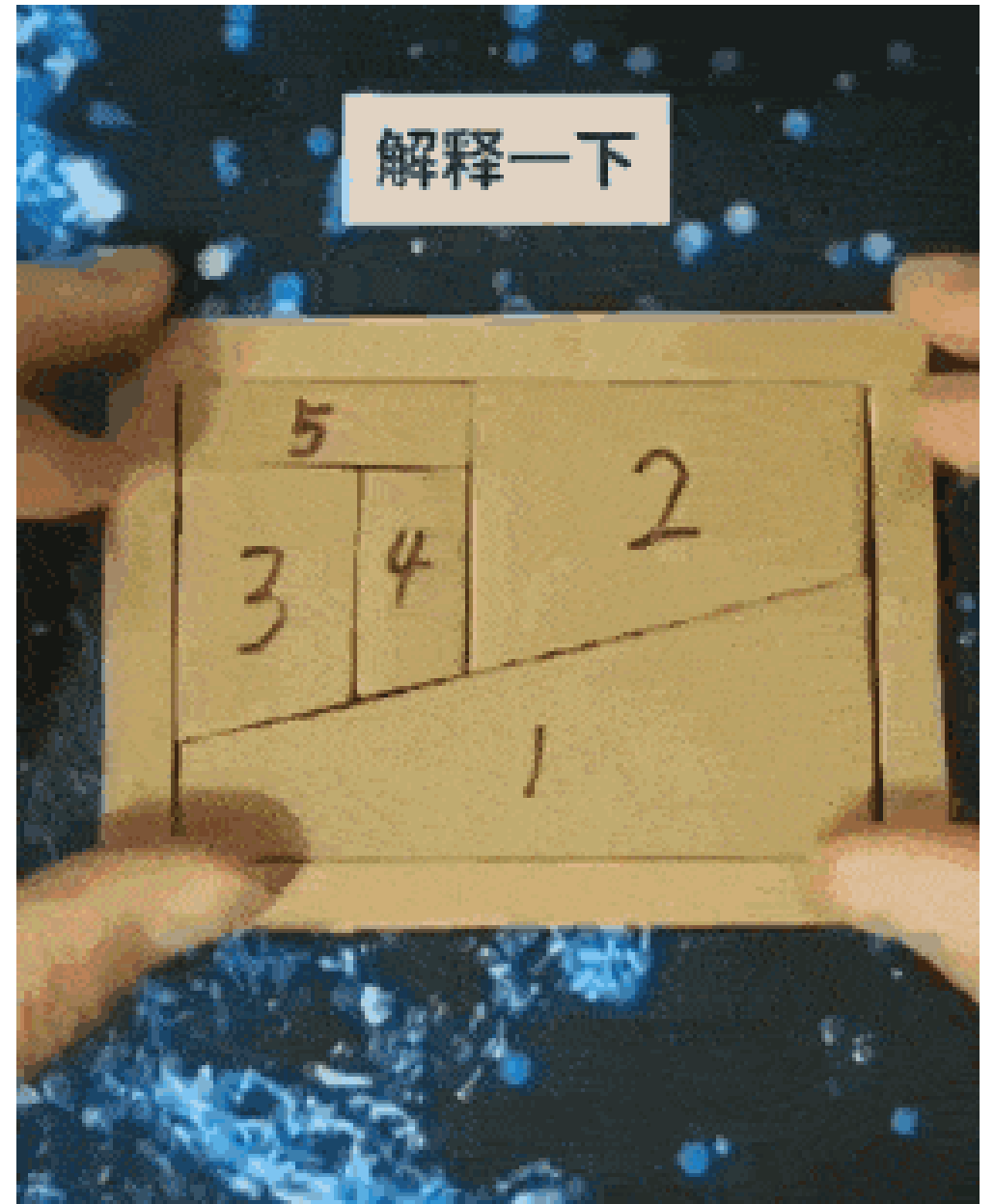


Is what we see what we get?

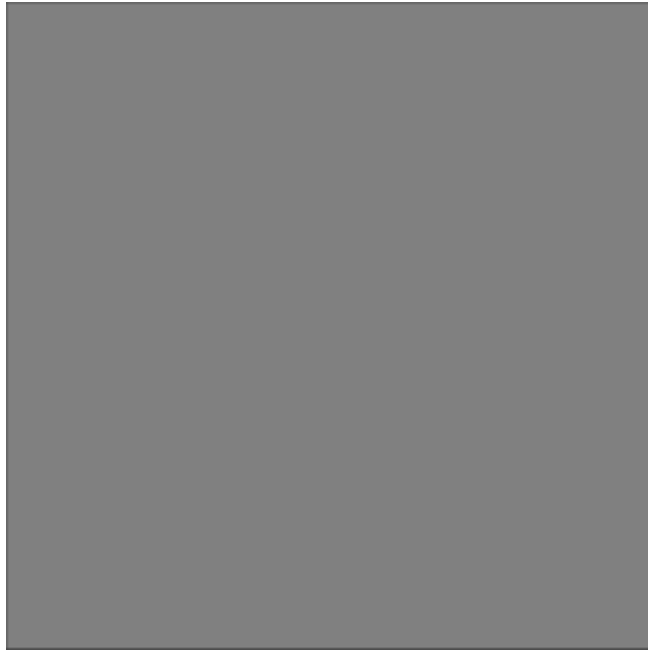


Which one is larger?

Visualization



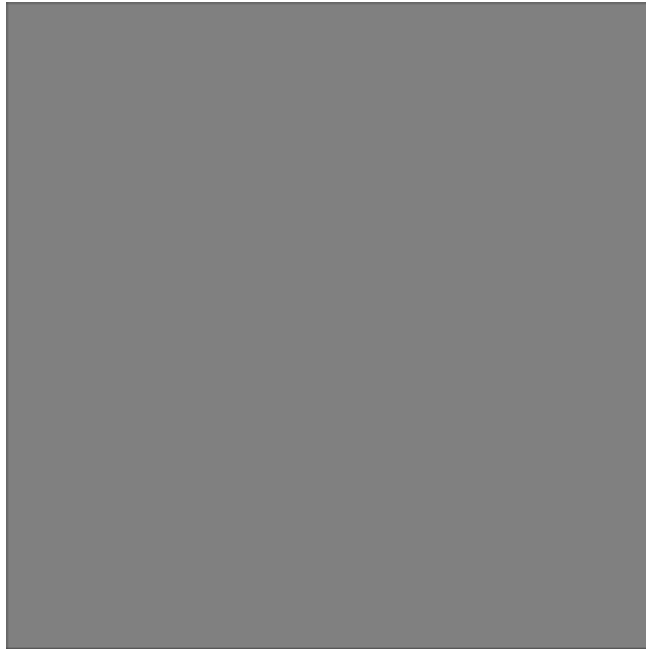
Magnitude Estimation



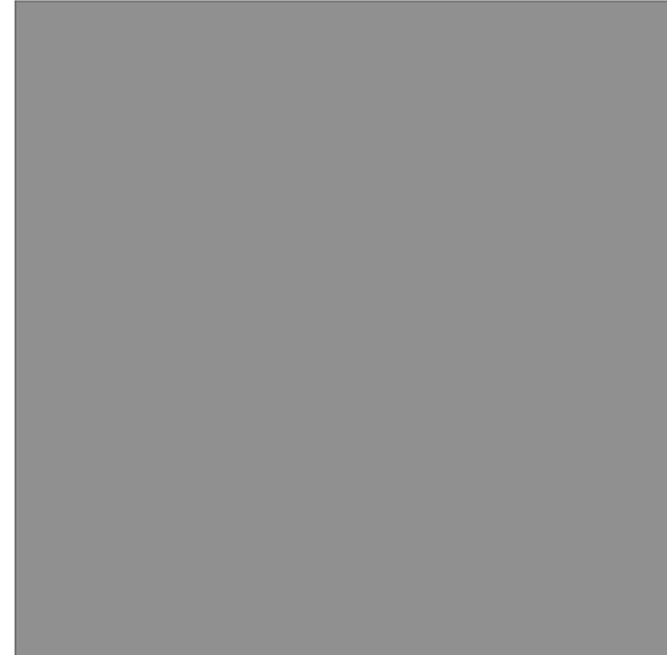
Which one is brighter?

Magnitude Estimation

(128, 128, 128)

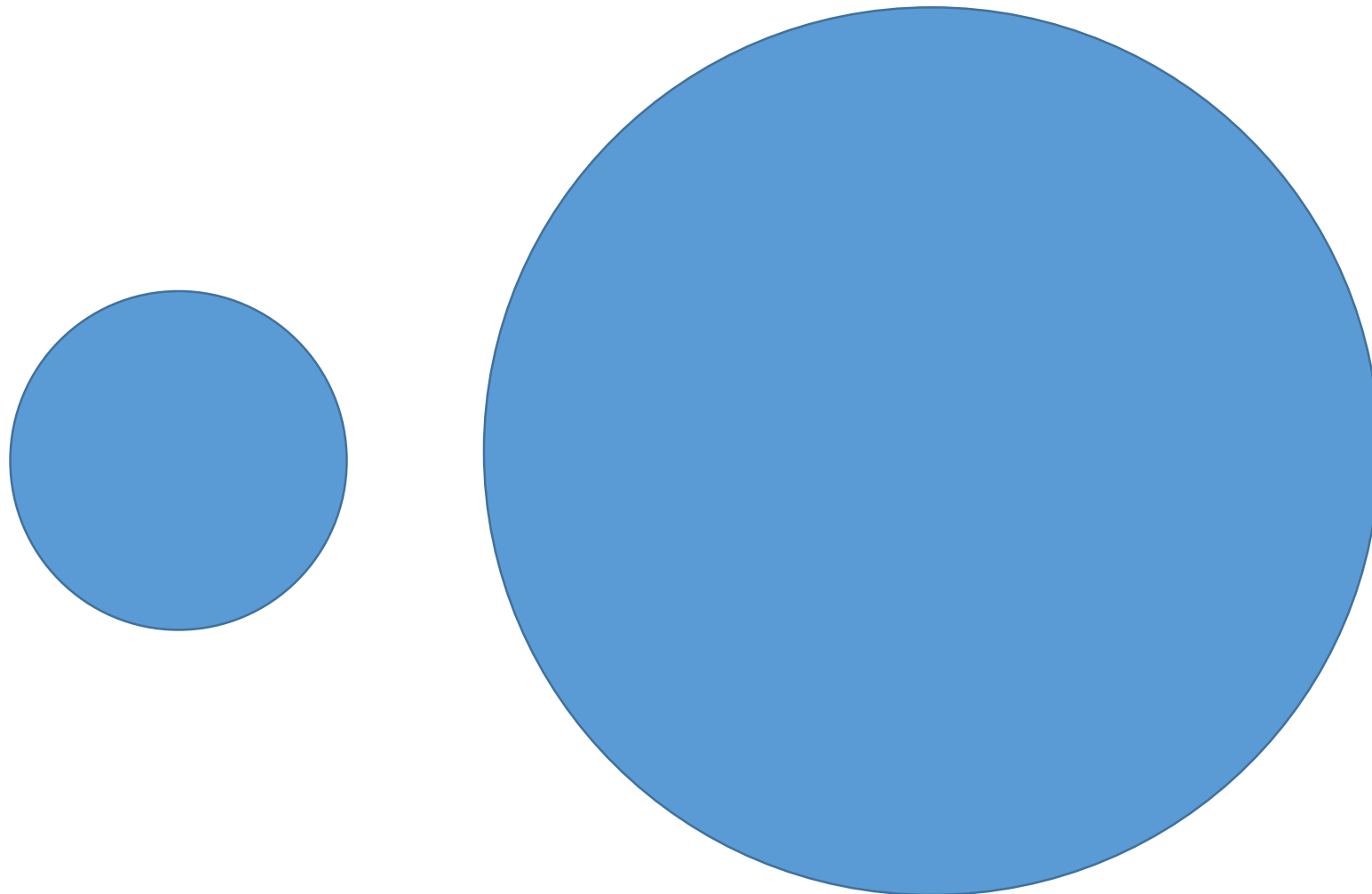


(144, 144, 144)

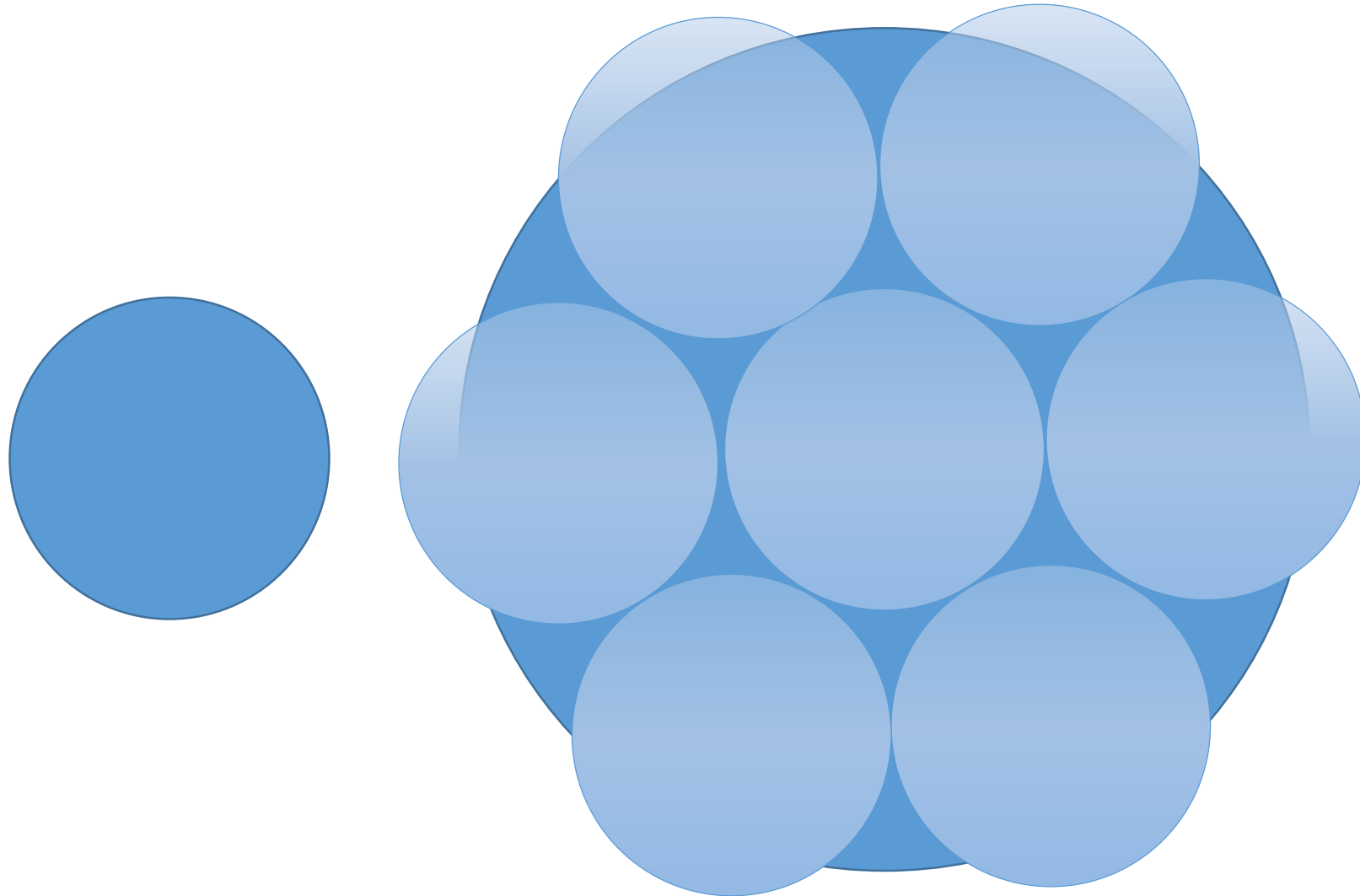


Which one is brighter?

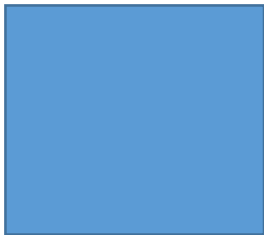
Magnitude Estimation



Magnitude Estimation



Magnitude Estimation



Magnitude Estimation



Magnitude Comparison

Most accurate



Least accurate



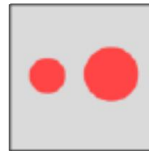
Length



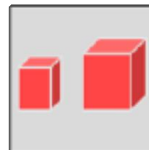
Slope



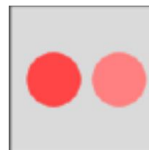
Angle



Area



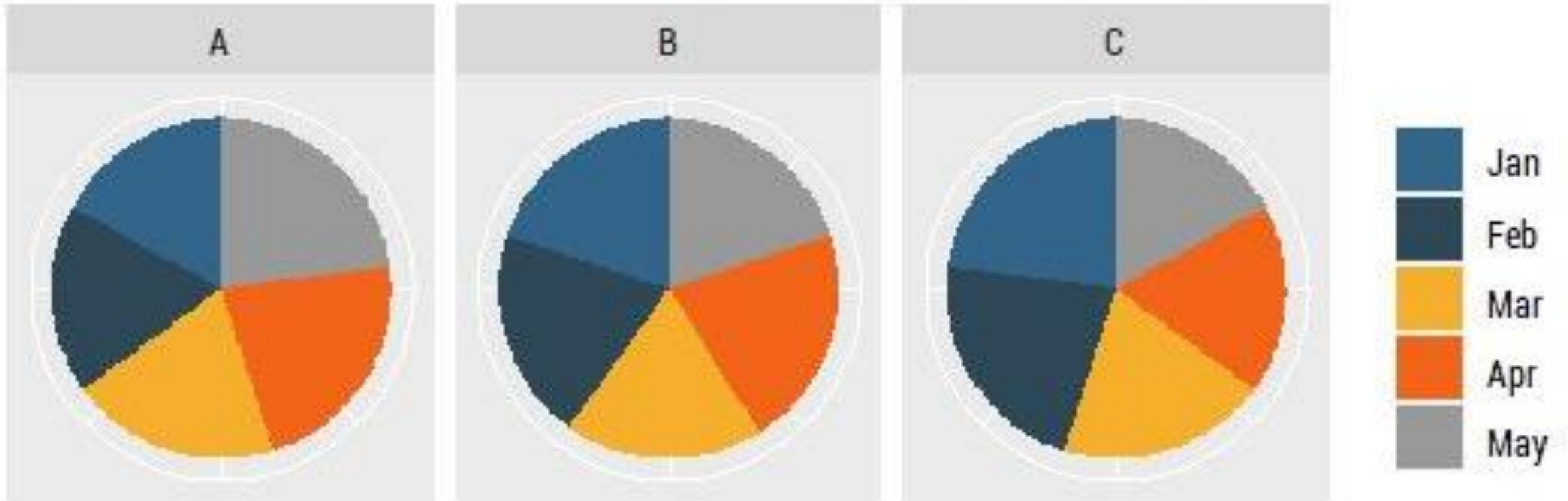
Volume



Color brightness

Remember this

- Pie Chart of Monthly Export by Country



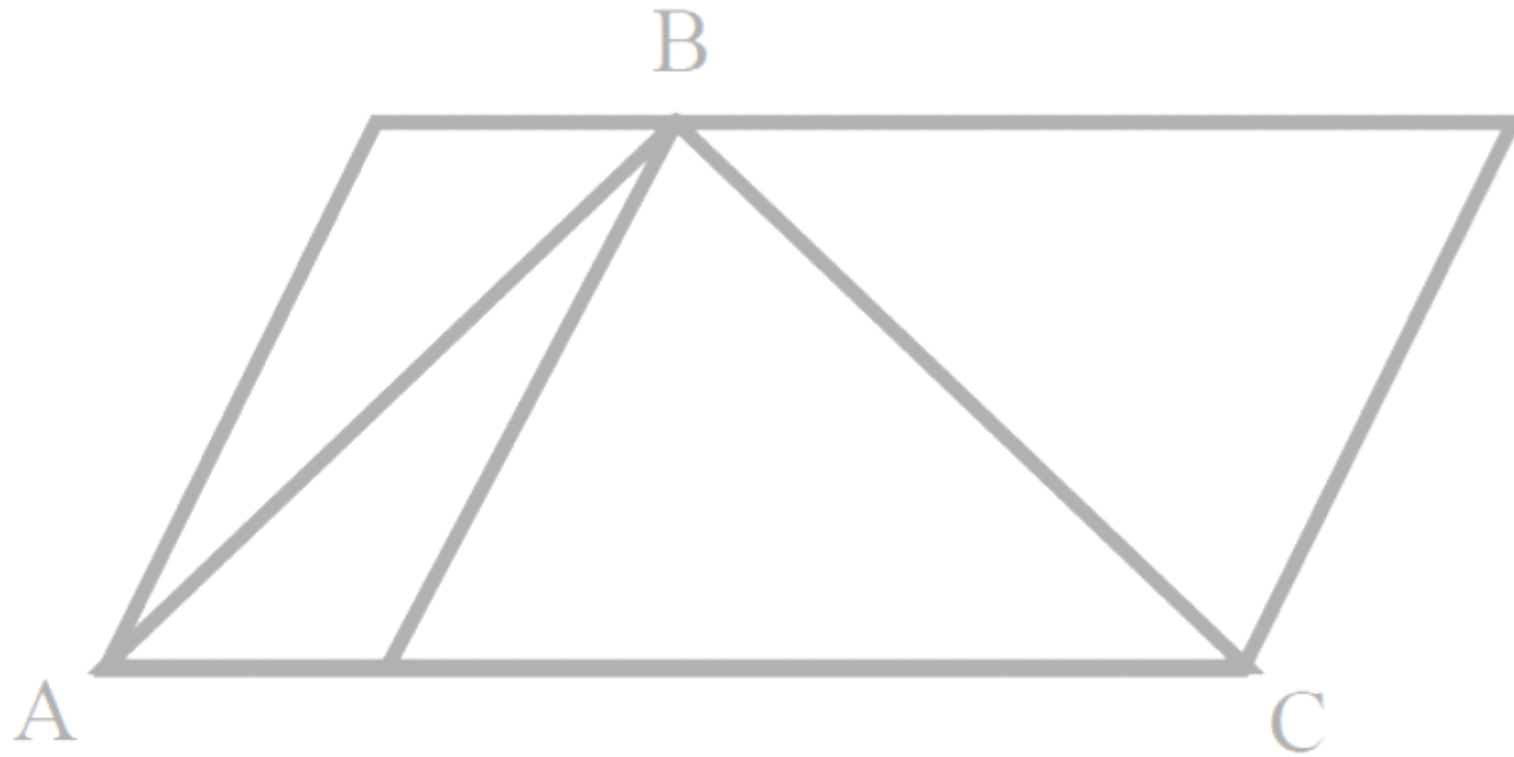
Remember this

- Bar Chart of Monthly Export by Country



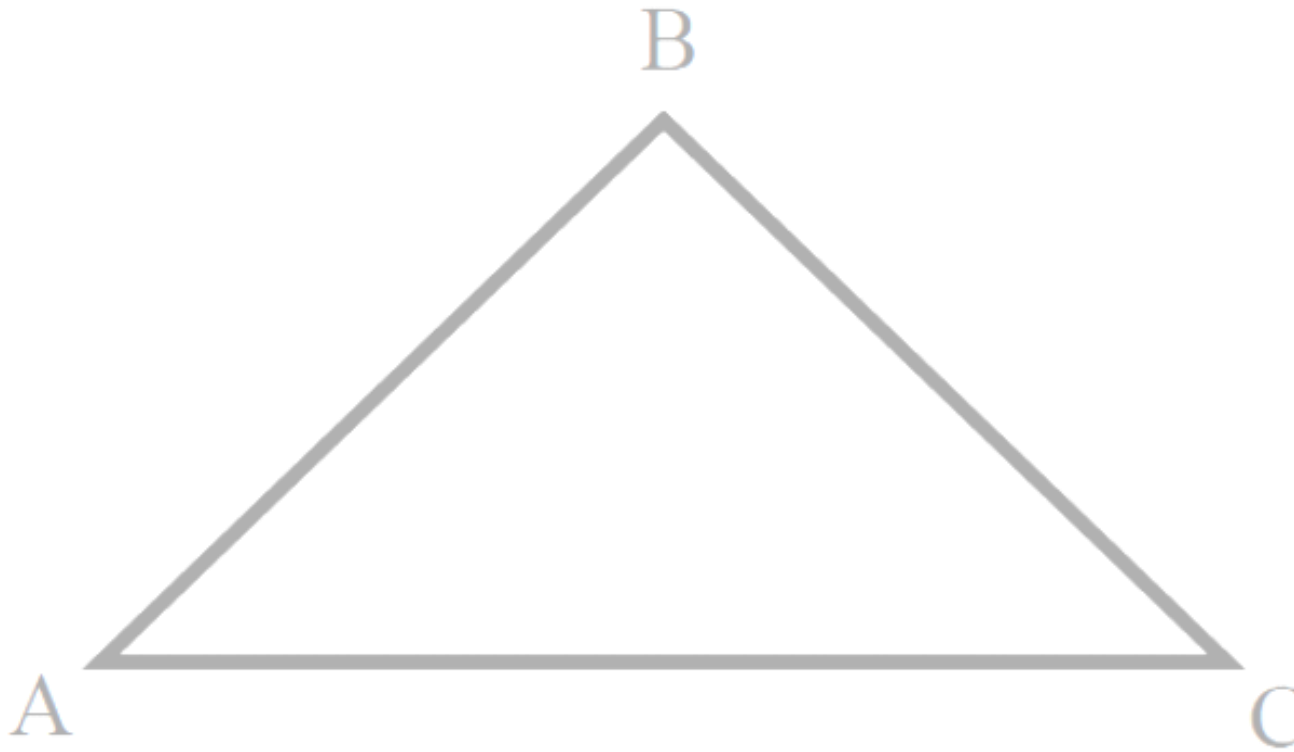
Size Context

- Which is longer, AB or BC?



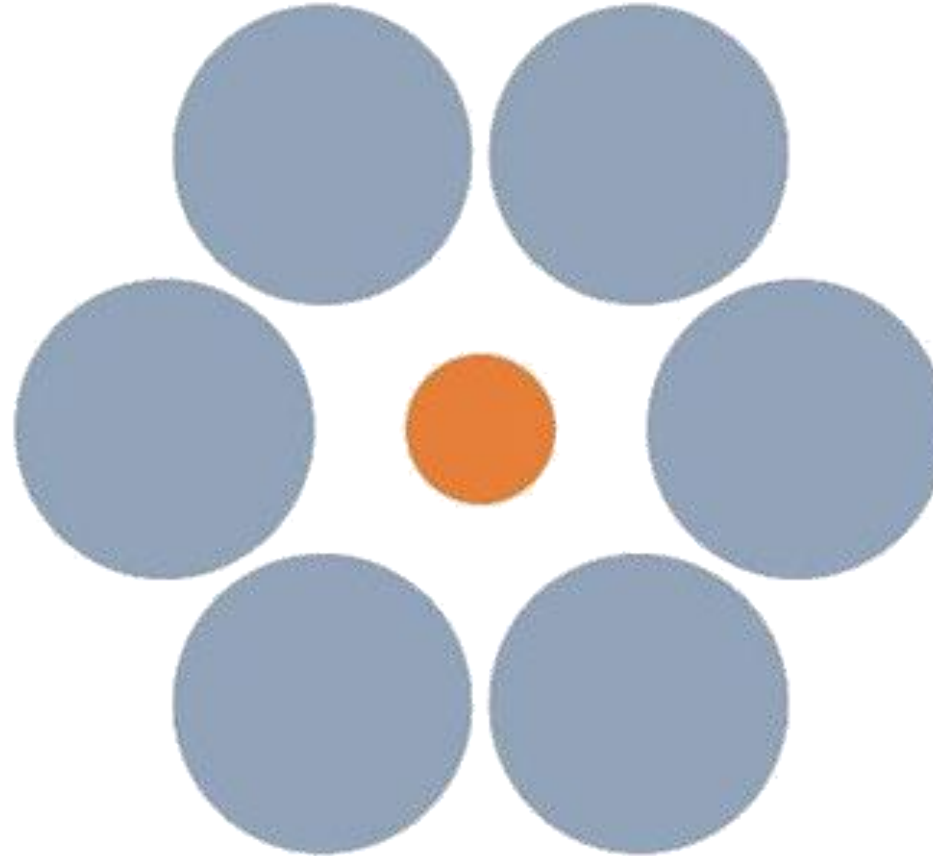
Size Context

- Which is longer, AB or BC?



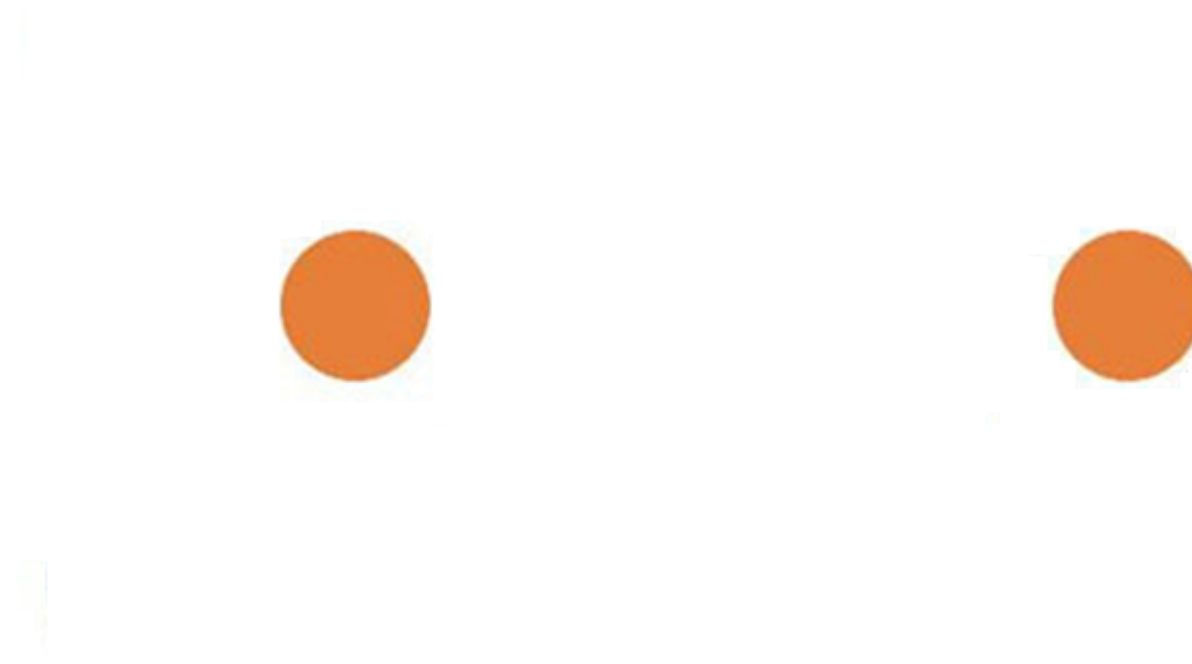
Size Context

- Which orange circle is larger?



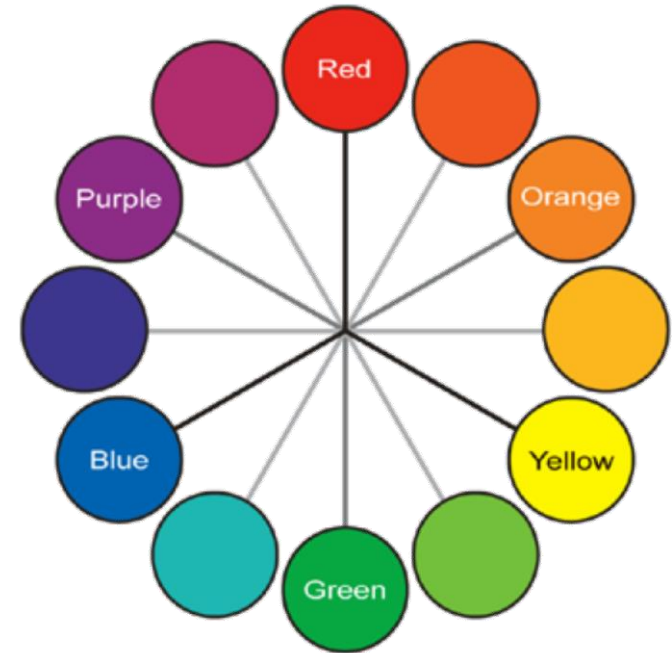
Size Context

=> always use consistent contexts for visual comparisons



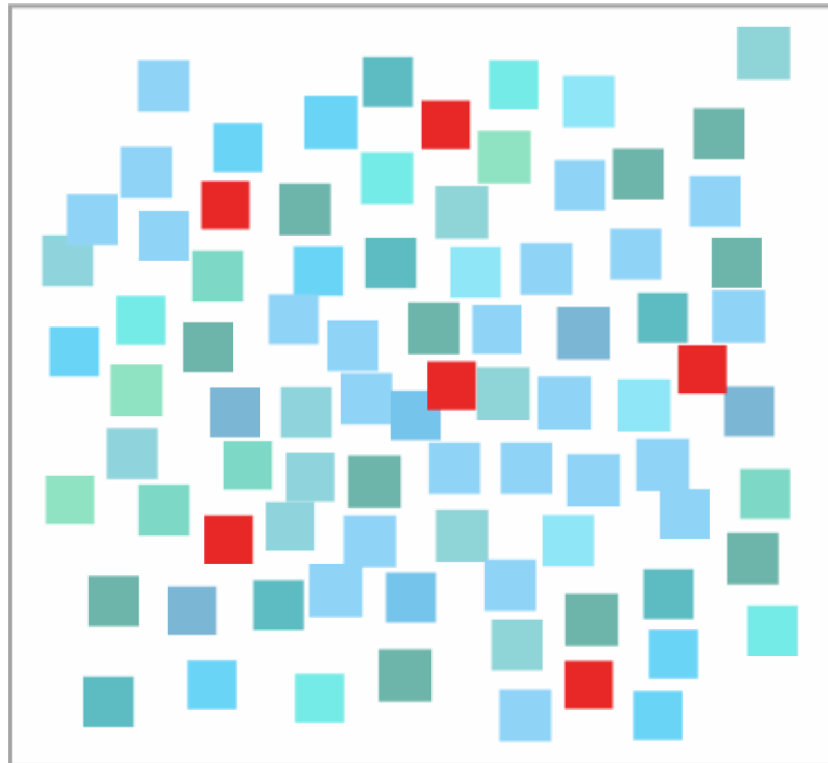
Principles of Color Design

- In color design, color is specified by three dimensions: hue, value, and chroma.
 - Hue is the color's name, such as red, green or orange.
 - Value is the perceived lightness or darkness of the color.
 - Chroma describes its colorfulness.



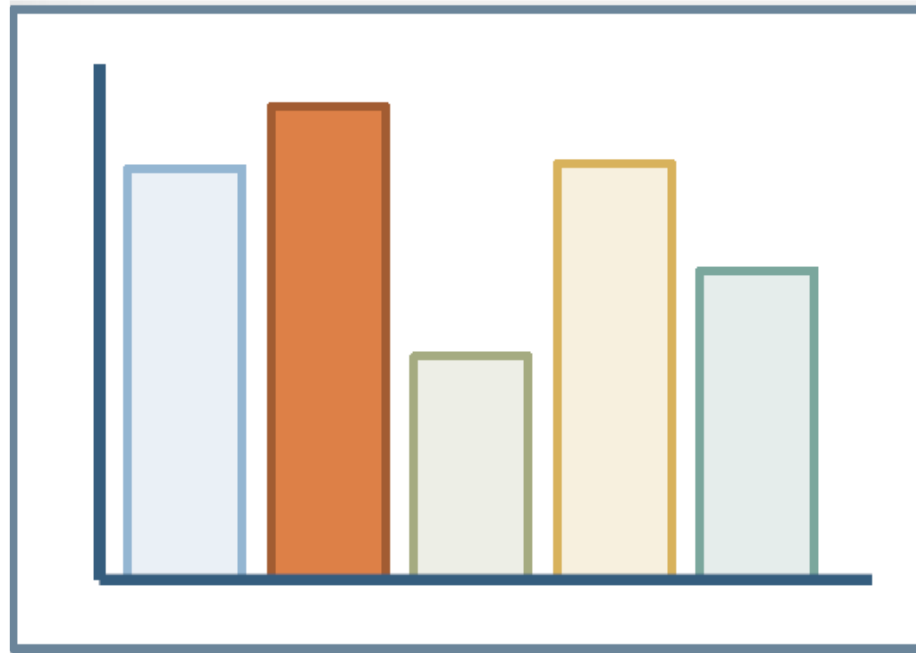
Principles of Color Design

- Contrast and analogy are the principles that define color design.
- Contrast draws attention, analogy groups



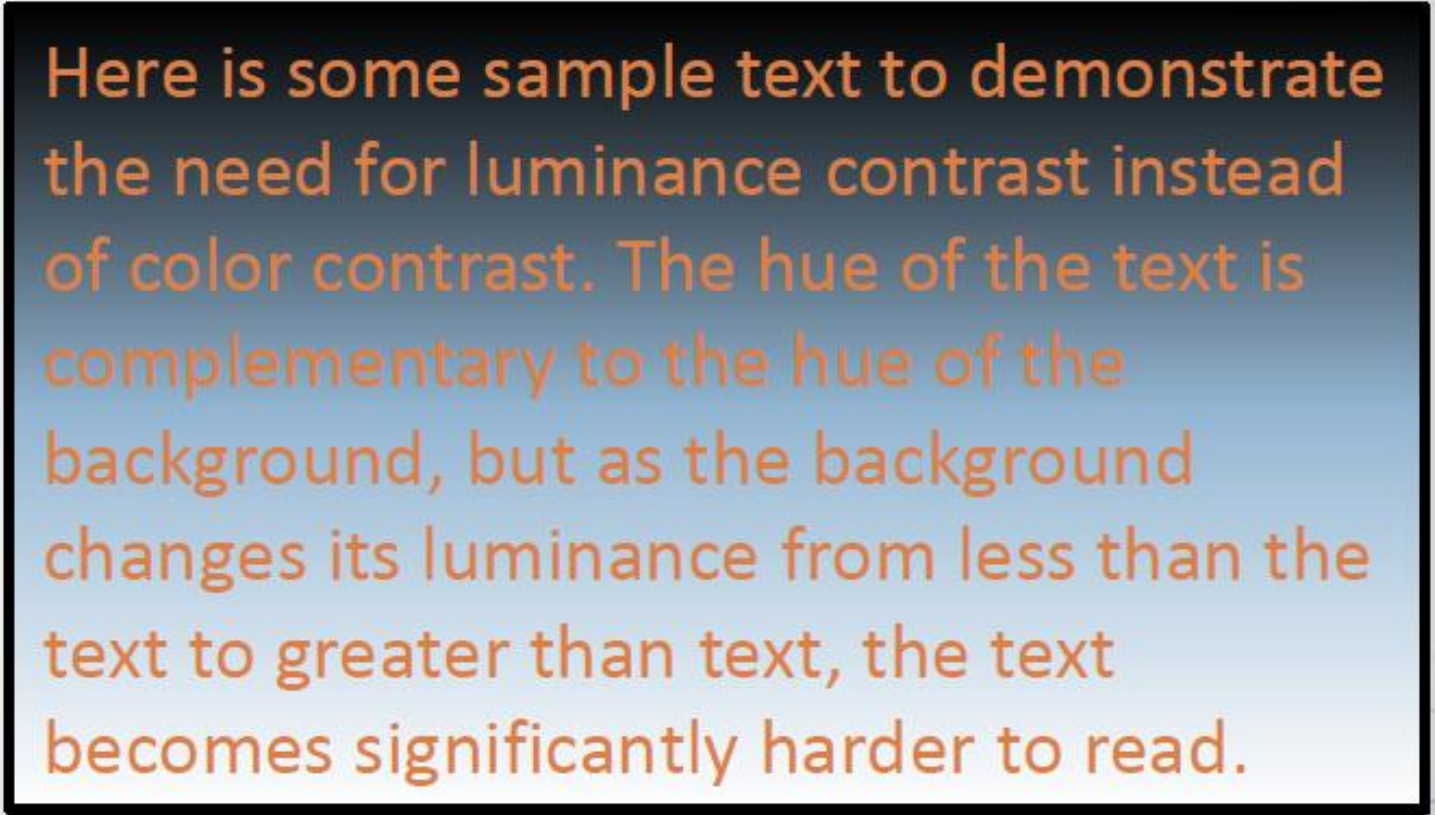
Contrast

- Use higher luminance contrast to gain attention



Legibility

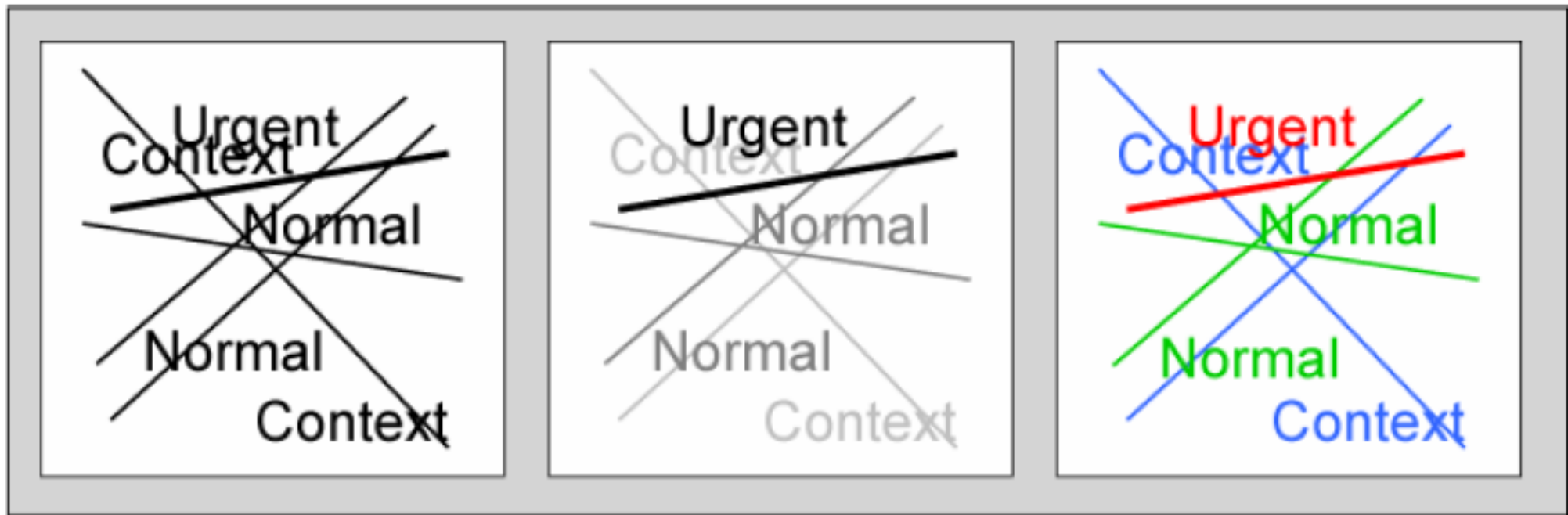
- Make sure text has sufficient luminance contrast

A rectangular box with a black border. The background of the box is a vertical gradient, transitioning from a dark blue at the top to a light blue at the bottom. The text inside the box is a reddish-orange color. The text is a paragraph explaining the importance of luminance contrast over color contrast for legibility.

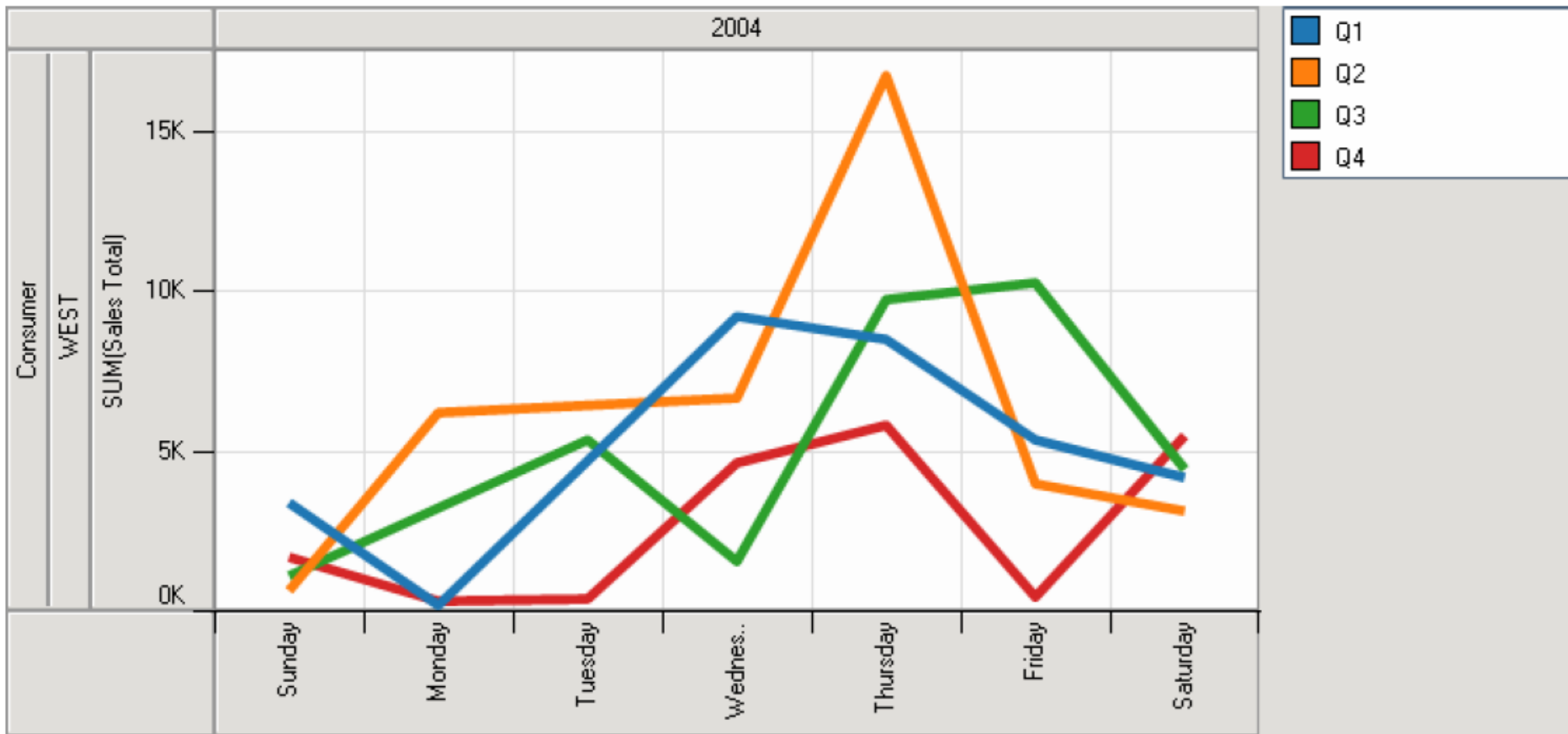
Here is some sample text to demonstrate the need for luminance contrast instead of color contrast. The hue of the text is complementary to the hue of the background, but as the background changes its luminance from less than the text to greater than text, the text becomes significantly harder to read.

Legibility

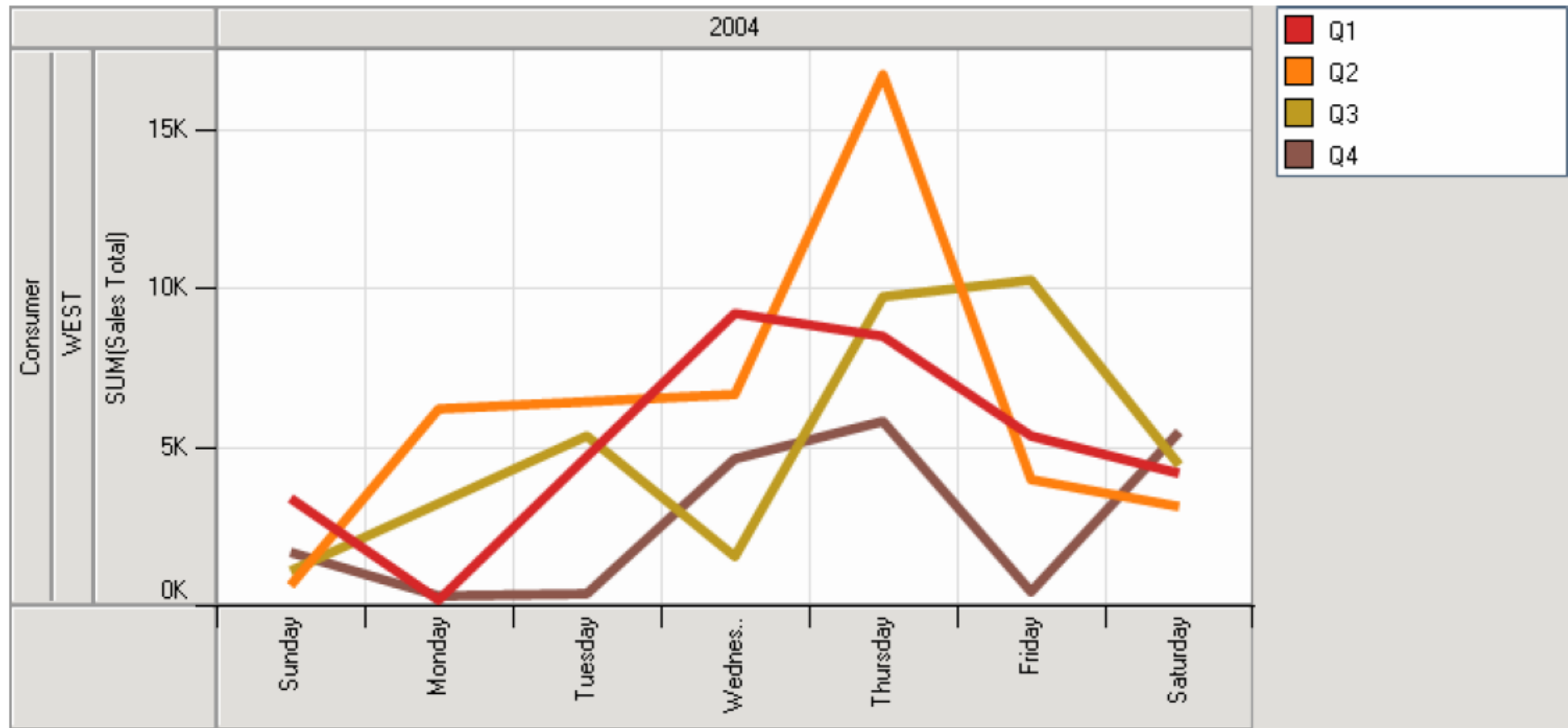
- Variation in luminance can also be used to separate overlaid values into layers, where low contrast layers can sit behind high contrast ones without causing visual clutter.



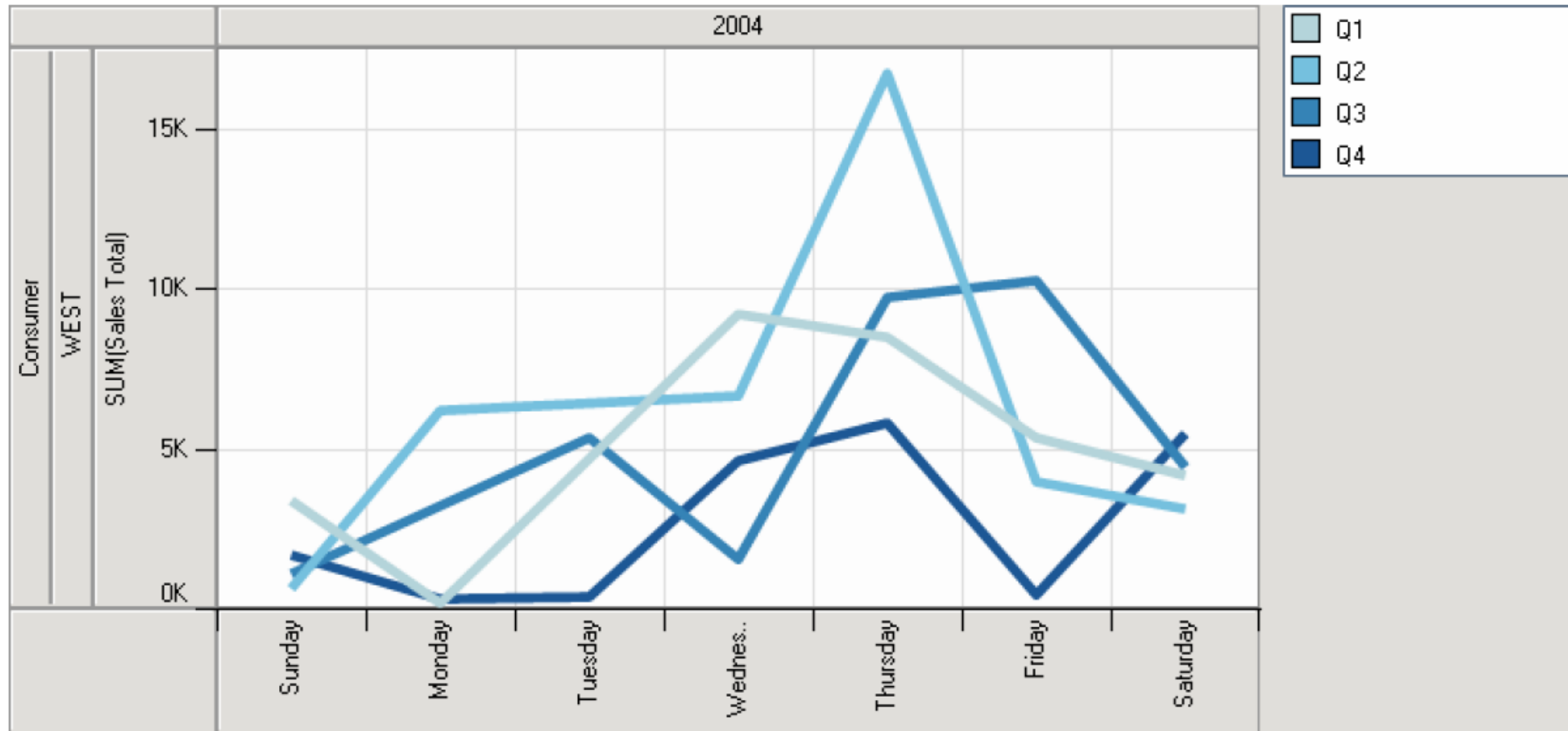
Example: Color changes human attention



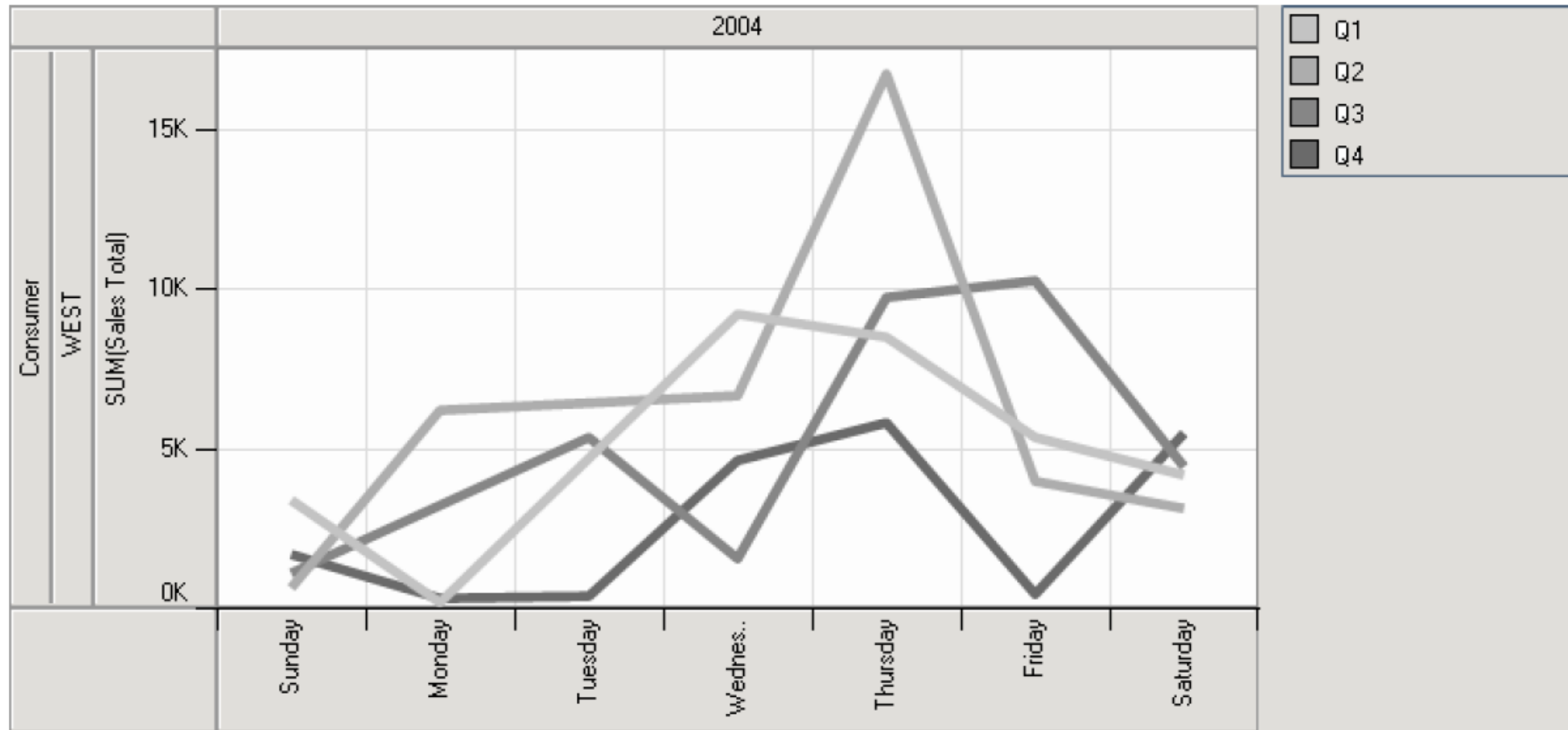
Color changes human attention



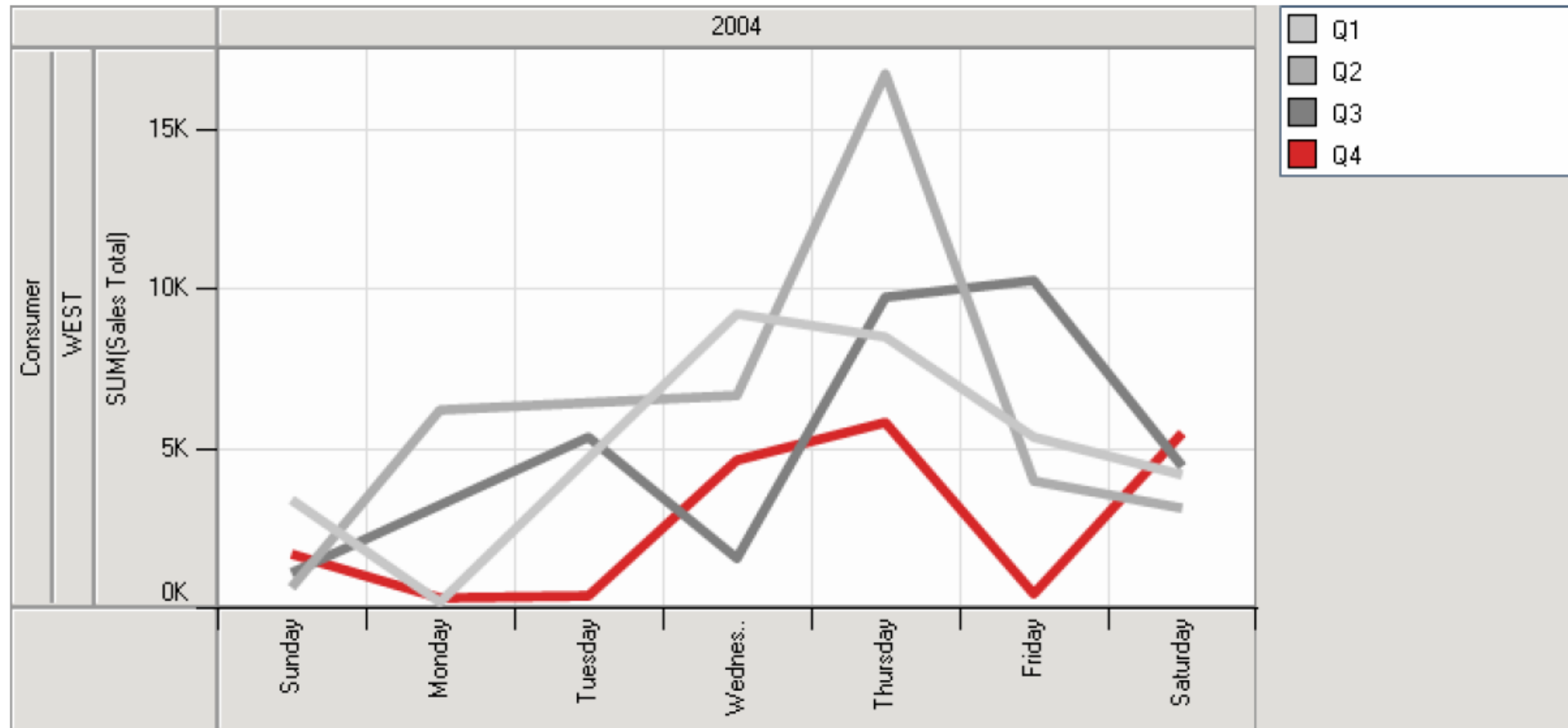
Color changes human attention



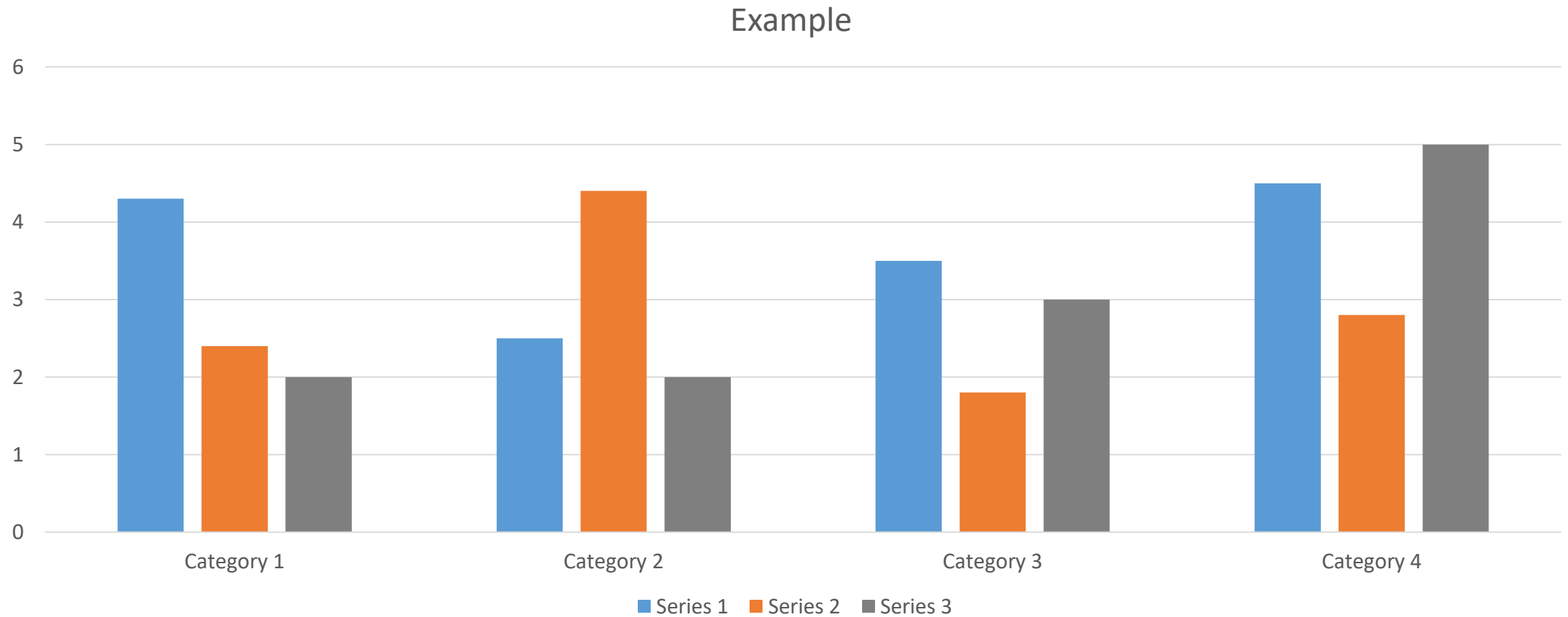
Color changes human attention



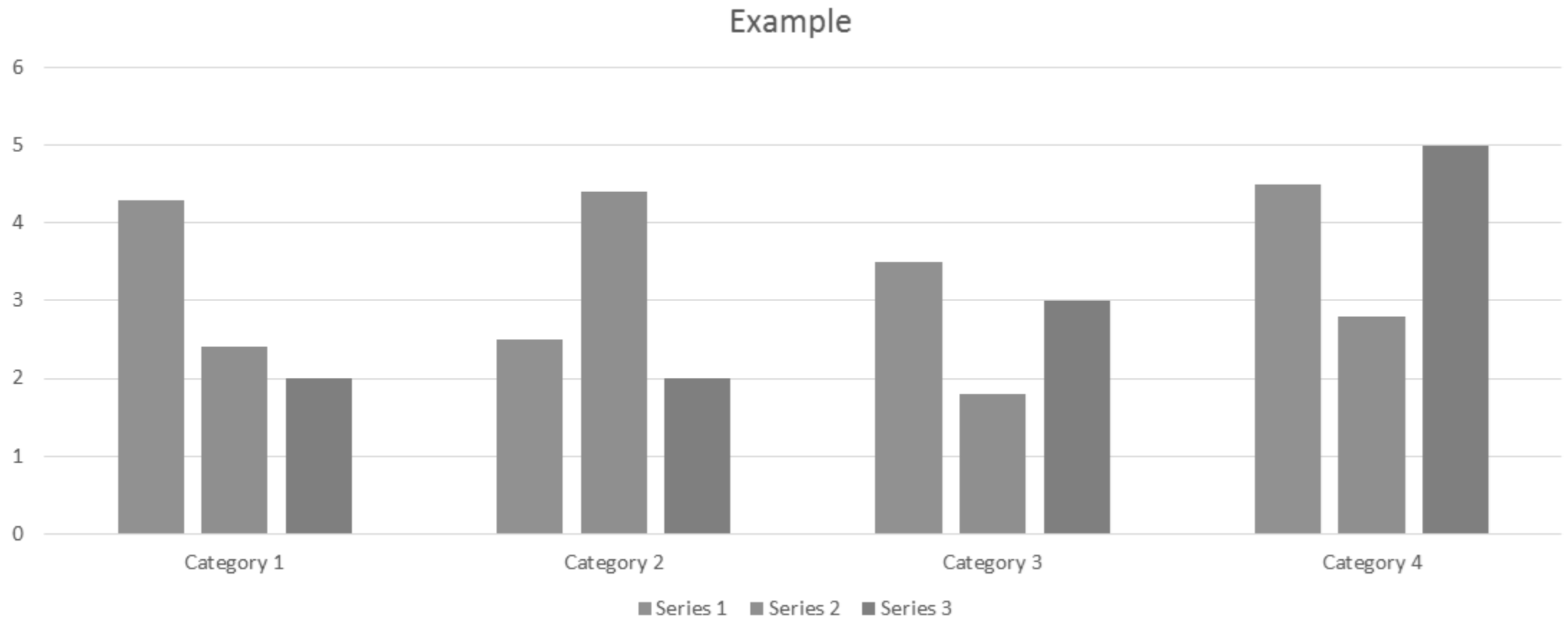
Color changes human attention



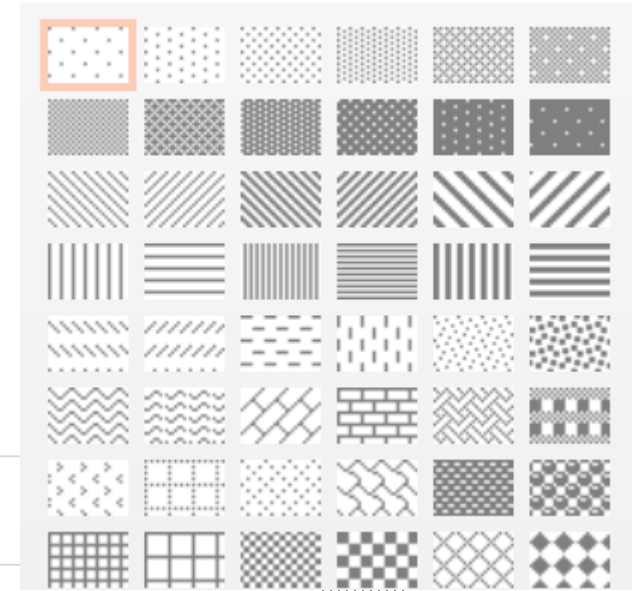
When color can't differentiate anything at all



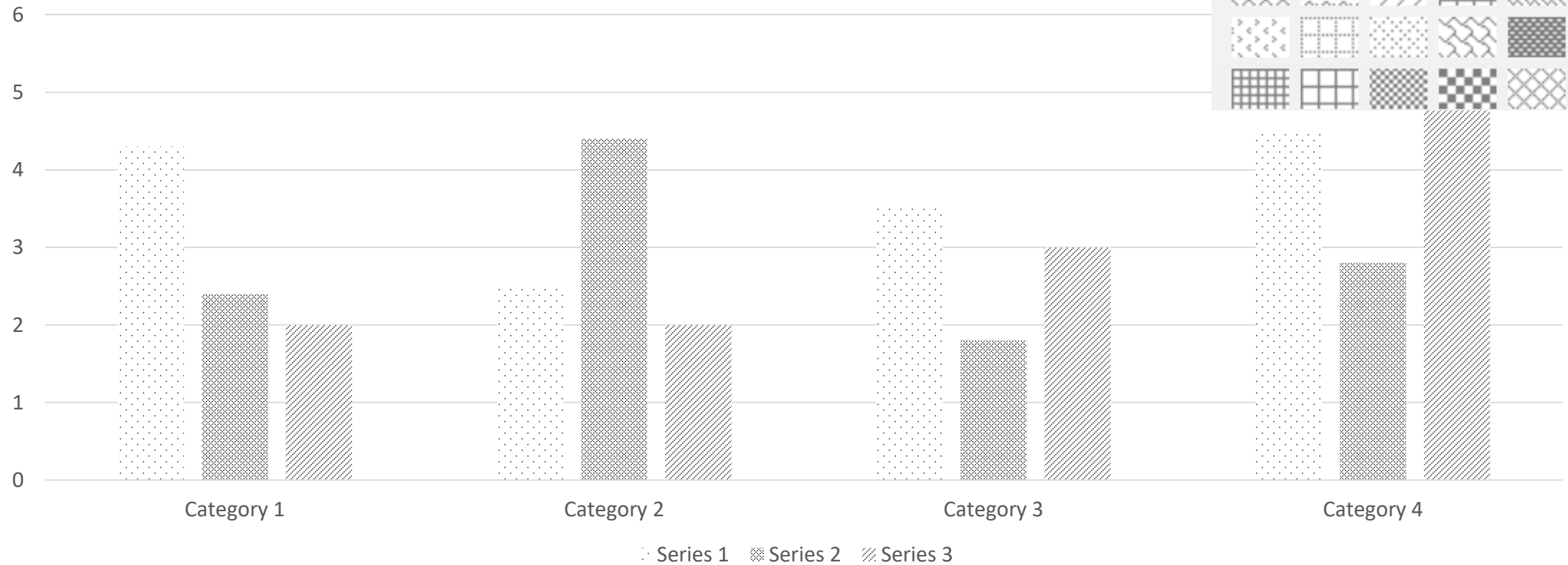
When color can't differentiate anything at all



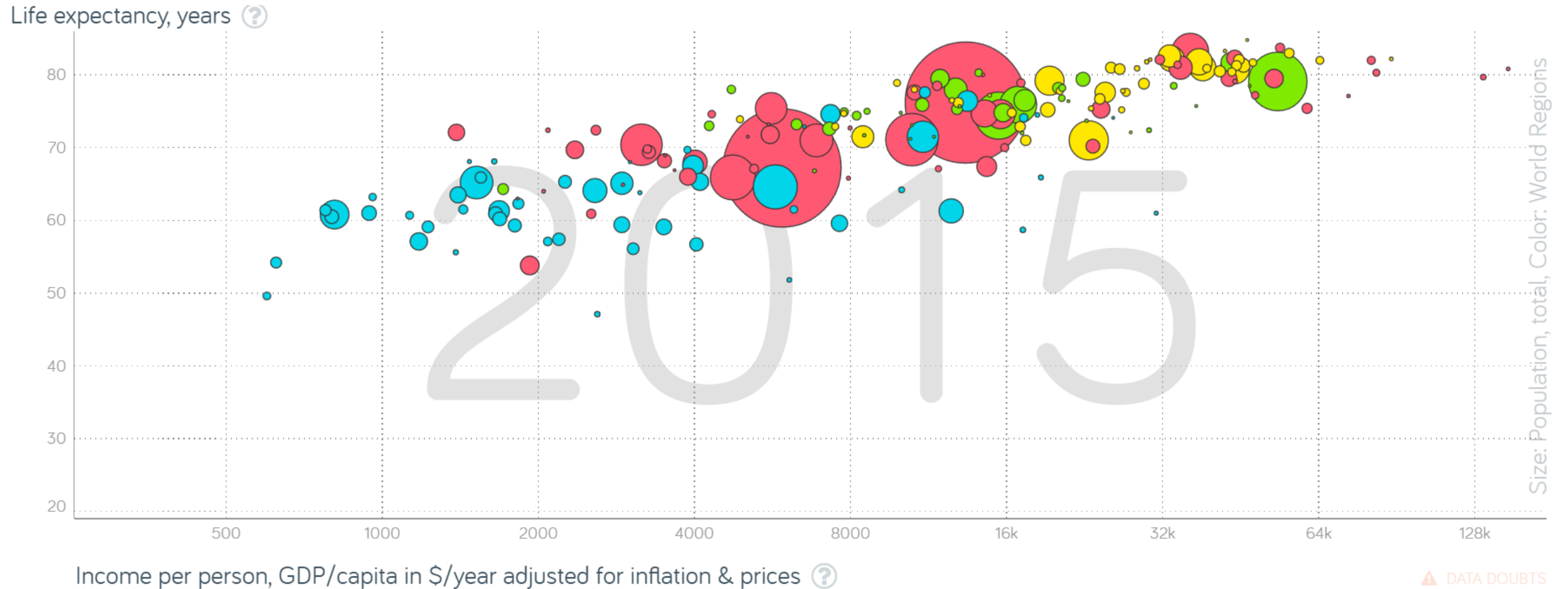
Using other fill, e.g., pattern fill



Example



Hans Rosling Revisit



Q&A