

03-2 Color

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3-2 Color -
Lecture

COLORS

Sungahn Ko
sako@unist.ac.kr

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Disclaimer

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- The slides cannot be distributed, posted or used outside of this class
- Slides in this course courtesy of
 - Dr. Abish Malik (Purdue)
 - Dr. Yun Jang (Sejong Univ.)
 - Dr. Ross Maciejewski (ASU)
 - Dr. Niklas Elmquist (UMD)
 - Dr. David Ebert (Purdue)

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Color

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- Results from research on visual attention can be used to assign visual features to data values
- One of the key components of visually representing data is choosing the appropriate color scale
- There is no “best” color scale
- Choice depends on^{1,2}
 - data type
 - problem domain
 - visual representation
 - Questions the analyst is asking of the data
- While there is no “best” choice, there are design principles

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Design Principles for Color Schemes

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- Order¹ – Given a univariate data type, the color scale that is chosen to map the data must represent a perceived ordering
- Separation² – Important differences between ranges of the variable should be represented by colors that can be perceived as being different
 - Not only should they be perceived as different, but also equal
- Aesthetics³ – color map should be aesthetically pleasing, contain a maximum perceptual resolution, and ordering should be intuitive

B. E. Trumbo, ‘Theory for Coloring Bivariate Statistical Maps,’

K. Morsland, ‘Diverging Color Maps for Scientific Visualization.’

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Univariate Color Schemes

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Qualitative

□ ?? scheme

- Rainbow color scale is one of the most commonly used, but it is a poor color map in a large variety of domain problems

Ordering

□ ?? of the hues is unintuitive

- Nominal data types can use this scale as no ?? is implied

Ex. names no ordering data



Best distinguish between colors

ordering

D. Borland and R. M. Taylor, "Rainbow Color Map (Still) Considered Harmful,"

, "Task
M. A. Harrower and C. A. Brewer, "ColorBrewer.org: An online tool for selecting color schemes for maps,"

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Univariate Color Schemes

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Sequential

□ ?? color scheme

- Simplest is the gray scale map where variable is mapped to brightness
- ?? maps represent ordered data
- Dark colors typically represent high ranges
- Benefits are that the scale is intuitive
- Weakness is that limited number of distinguishable colors can be represented



D. Borland and R. M. Taylor, "Rainbow Color Map (Still) Considered Harmful,"

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Univariate Color Schemes

7 Divergent

?? color scheme



- Provides means for variable comparisons
- Best suited for ?? data where there is some meaningful ?? point
- Careful choices must be made in choosing high and low ends *(Based on cultures, target domain, target users ...)*
- Can use concept of cool (blues) and warm (reds and yellow) colors

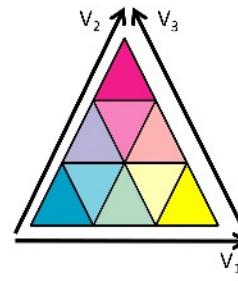
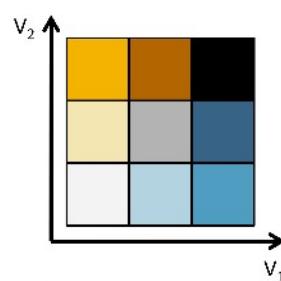
"Task
M. A. Harrower and C. A. Brewer, "ColorBrewer.org: An online tool for selecting color schemes for maps."

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Multivariate Color Schemes

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To choose colors for data

- <http://colorbrewer2.org/#type=sequential&scheme=BuGn&n=3>

M. A. Harrower and C. A. Brewer, "ColorBrewer.org: An online tool for selecting color schemes for maps."

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Using Color

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- Use ?? in large regions, not thin lines
- Use ?? and ?? in the center of the field of view (edges of retina not sensitive to these)
- Use ??, ?? and ?? in the periphery
- Use adjacent colors that vary in hue
- For large regions, don't use highly saturated colors (try pastels)
- Do not use adjacent colors that vary in amount of ??
- Use color for grouping and search
- Beware effects from adjacent color regions

Stasko's

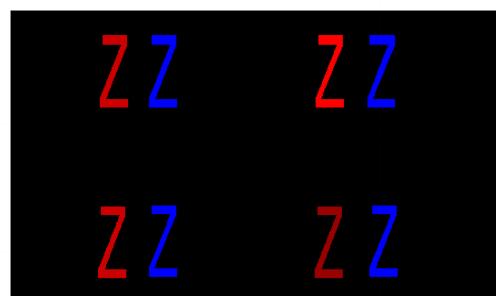
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Using Color

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Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?
 Hello, here is some text. Can you read what it says?



Since these letters are all presented on your video monitor, they obviously are all located in the same plane. But do all the Z's appear to be in the same plane or do some appear closer than others?

Stasko's

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Definitions

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- Dominant Wavelength:
 - The wavelength of color we “see” when viewing light
- Excitation Purity:
 - Proportion of pure light of the dominant wavelength and of white light needed to define the color
- Luminance:
 - The amount/intensity of light

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Definitions

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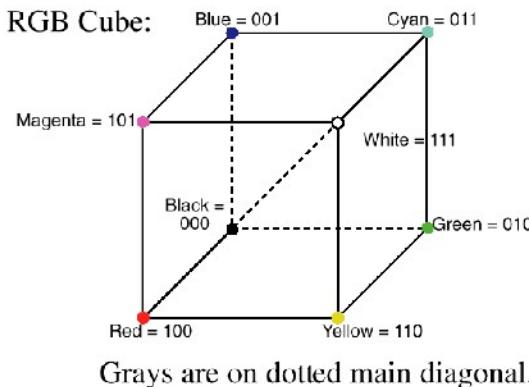
- Hue:
 - What we usually call “color” of the light
- Saturation (chroma)
 - Amount of white mixed in the color
 - “Saturated” color has no white in it
 - Saturation of white is 0%
- Intensity
 - Lightness for reflecting objects
 - Brightness for self-luminous objects
 - Is proportional to energy
 - May be reduced by adding water to the color
- Artists use hue, saturation and intensity to describe colors.

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RGB Color Space

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What's Wrong with RGB?

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Interpolation

- ?? in RGB will not give correct perceptual information
- RGB linear color maps will give incorrect information

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Possible Alternative for RGB Interpolation

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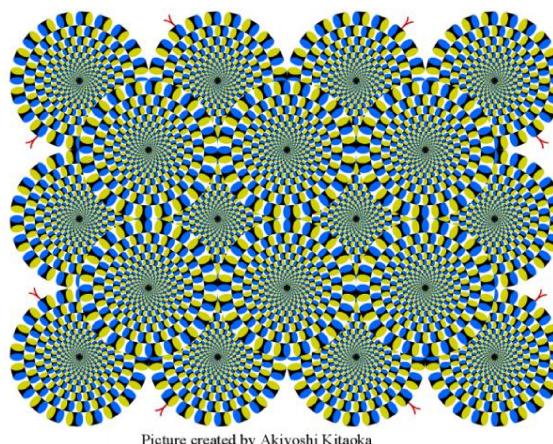
- Use Hue, Saturation, and Value
- HSV color space
- https://en.wikipedia.org/wiki/HSL_and_HSV

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Visualization in the Periphery

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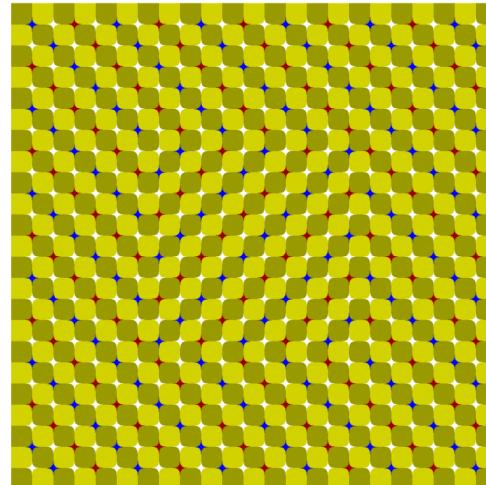
Picture created by Akiyoshi Kitaoka

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Visualization in the Periphery

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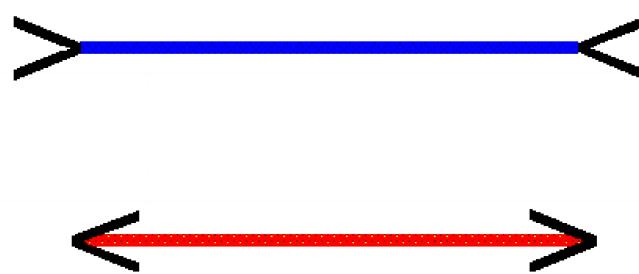


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Another Illusion

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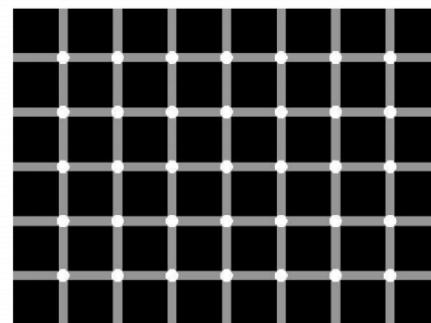


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Count the Black Dots

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Count the black dots! :o)

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Questions?

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