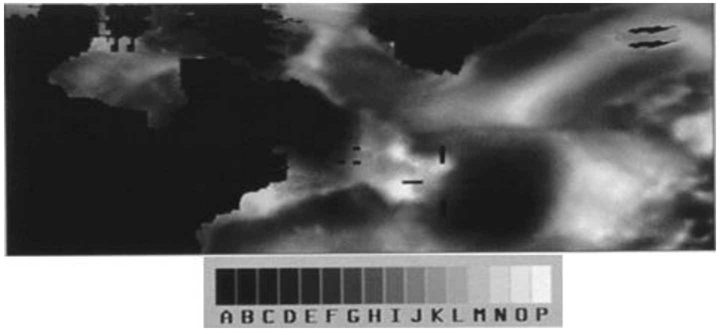
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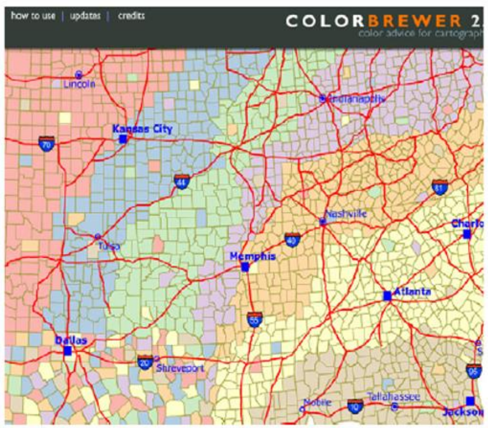
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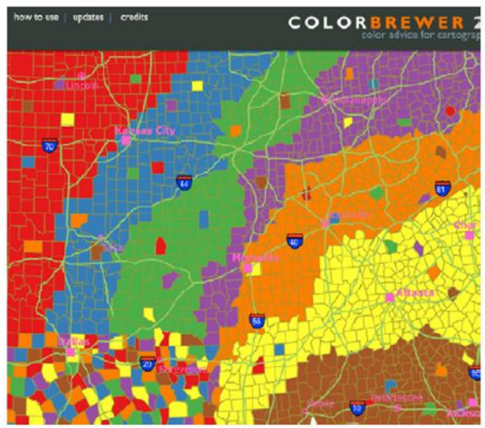
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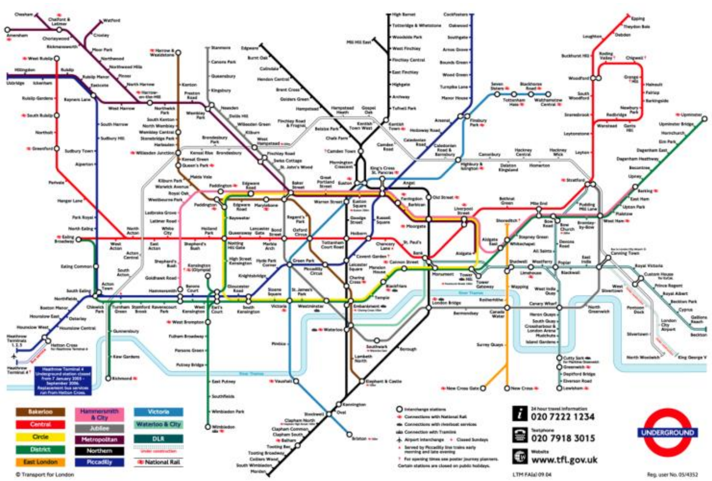
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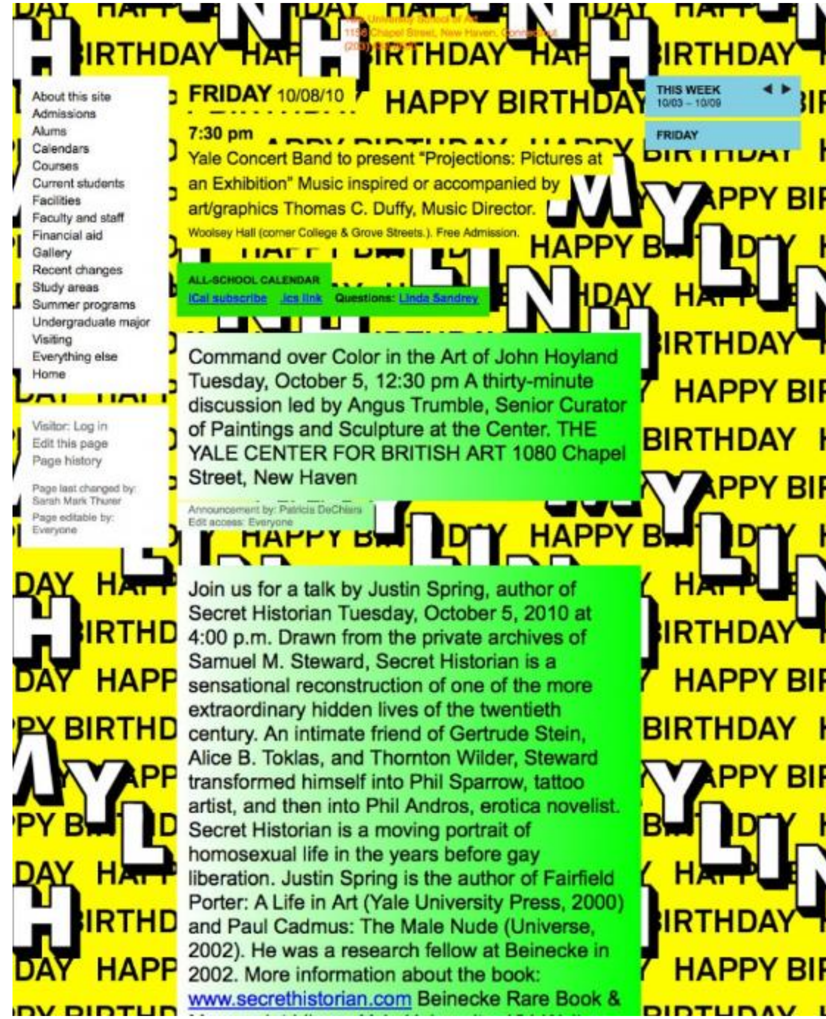
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THIS WEEK
10/03 – 10/09
FRIDAY
7:30 pm
Yale Concert Band to present "Projections: Pictures at an Exhibition" Music inspired or accompanied by art/graphics Thomas C. Duffy, Music Director.
Woolsey Hall (corner College & Grove Streets.). Free Admission.
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Questions: Linda Sandrey
Command over Color in the Art of John Hoyland Tuesday, October 5, 12:30 pm A thirty-minute discussion led by Angus Trumble, Senior Curator of Paintings and Sculpture at the Center. THE YALE CENTER FOR BRITISH ART 1080 Chapel Street, New Haven
Join us for a talk by Justin Spring, author of Secret Historian Tuesday, October 5, 2010 at 4:00 p.m. Drawn from the private archives of Samuel M. Steward, Secret Historian is a sensational reconstruction of one of the more extraordinary hidden lives of the twentieth century. An intimate friend of Gertrude Stein, Alice B. Toklas, and Thornton Wilder, Steward transformed himself into Phil Sparrow, tattoo artist, and then into Phil Andros, erotica novelist. Secret Historian is a moving portrait of homosexual life in the years before gay liberation. Justin Spring is the author of Fairfield Porter: A Life in Art (Yale University Press, 2000) and Paul Cadmus: The Male Nude (Universe, 2002). He was a research fellow at Beinecke in 2002. More information about the book: www.secrethistorian.com Beinecke Rare Book &

Visual Perception

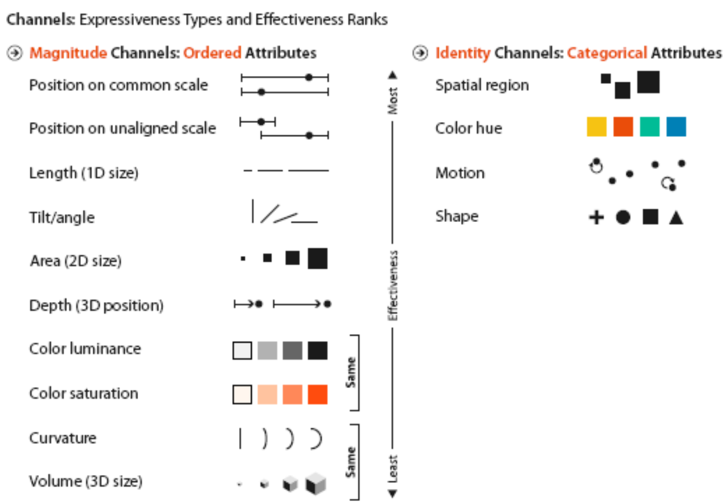


Figure 5.1. The effectiveness of channels that modify the appearance of marks depends on matching the expressiveness of channels with the attributes being encoded.

Chapter 5

Marks and Channels

5.1 The Big Picture

Marks are basic geometric elements that depict items or links, and channels control their appearance. The effectiveness of a channel for encoding data depends on its type: the channels that perceptually convey magnitude information are a good match for ordered data, and those that convey identity information with categorical data. Figure 5.1 summarizes the channel rankings.

5.2 Why Marks and Channels?

Learning to reason about marks and channels gives you the building blocks for analyzing visual encodings. The core of the design space of visual encodings can be described as an orthogonal combination of two aspects: graphical elements called marks, and visual channels to control their appearance. Even complex visual encodings can be broken down into components that can be analyzed in terms of their marks and channel structure.

5.3 Defining Marks and Channels

A **mark** is a basic graphical element in an image. Marks are geometric primitive objects classified according to the number of spatial dimensions they require. Figure 5.2 shows examples: a zero-dimensional (0D) mark is a point, a one-dimensional (1D) mark is a line, and a two-dimensional (2D) mark is an area. A three-dimensional (3D) volume mark is possible, but they are not frequently used.

- No Unjustified 3D
  - The Power of the Plane
  - The Disparity of Depth
  - Occlusion Hides Information
  - Perspective Distortion Dangers
  - Tilted Text Isn't Legible
- No Unjustified 2D
- Eyes Beat Memory
- Resolution over Immersion
- Overview First, Zoom and Filter, Detail on Demand
- Responsiveness Is Required
- Get It Right in Black and White
- Function First, Form Next

Figure 6.1. Eight rules of thumb.

Chapter 6

Rules of Thumb

6.1 The Big Picture

This chapter contains **rules of thumb**: advice and guidelines. Each of them has a catchy title in hopes that you'll remember it as a slogan. Figure 6.1 lists these eight rules of thumb.

6.2 Why and When to Follow Rules of Thumb?

These rules of thumb are my current attempt to synthesize the current state of knowledge into a more unified whole. In some cases I refer to empirical studies, in others I make arguments based on my own experience, and some have been proposed in previous work. They are not set in stone; indeed, they are deeply incomplete. The characterization of what idioms are appropriate for which task and data abstractions is still an ongoing research frontier, and there are many open questions.

6.3 No Unjustified 3D

Many people have the intuition that if two dimensions are good, three dimensions must be better—after all, we live in a three-dimensional world. However, there are many difficulties in visually encoding information with the third spatial dimension, depth, which has important differences from the two planar dimensions.

In brief, 3D vis is easy to justify when the user's task involves shape understanding of inherently three-dimensional structures. In this case, which frequently occurs with inherently spatial data, the benefits of 3D absolutely outweigh the costs, and designers can use the many interaction idioms designed to mitigate those costs.

In all other contexts, the use of 3D needs to be carefully justified. In most cases, rather than choosing a visual encoding using

A High-Level Understanding

Seeing Is Believing?!

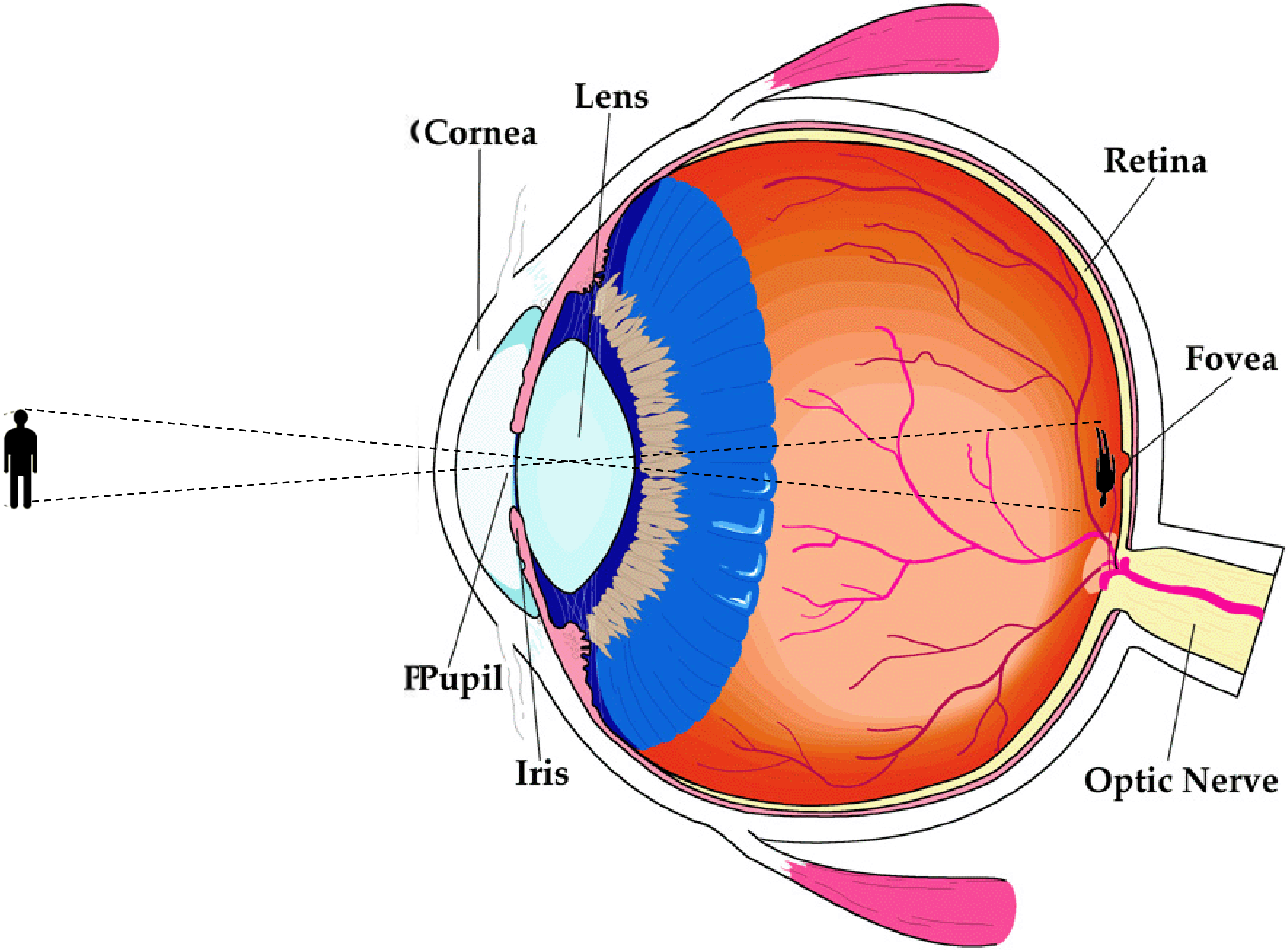
- Videos
  - http://www.simonslab.com/videos.html

Why?

What’s Going on?

- We don’t "see" everything in the world.
  - What we see is very selective.
  - "The world is its own memory. "
  - The result of mentally registering objects obtained by our eyes.

Eye and Visual Image



Do We See Up-Side-Down, Flat, Dotted Objects?

Visual Perception: Eye-Brain System

- Eye: A sensor to capture external stimuli
- Brain: A machine to store and process captured information

- Results of mental processes on sensory information
  - Millions of separate cells in retina → unified objects
  - 2D images → 3D world
  - Upside down image → perceived right side up world
  - Judgment on object size, distance, movement, ..

Implications of Brain Involvement

- We know outside worlds better.
  - Meanings of objects.
- Our seeing is limited by what our brain can do.
  - Limited cognitive capacities
    - Attention: how many things we can pay attention to
    - Memory: how many things our brain can register, remember, and retrieve.
    - Speed: how fast our brain can process information and make sense of it.

A Simple Exercise: Limitation of Our Memory

Pencil

Keyboard

Car

Glove

Newspaper

Watch

Coffee

Tree

Seat

Bread

How Many Objects Can You Recall?

Pencil

Keyboard

Car

Glove

Newspaper

Watch

Coffee

Tree

Seat

Bread

Brain May Tell Us Something Wrong or Misleading!

- Visual Illusions
  - http://www.michaelbach.de/ot/index.html

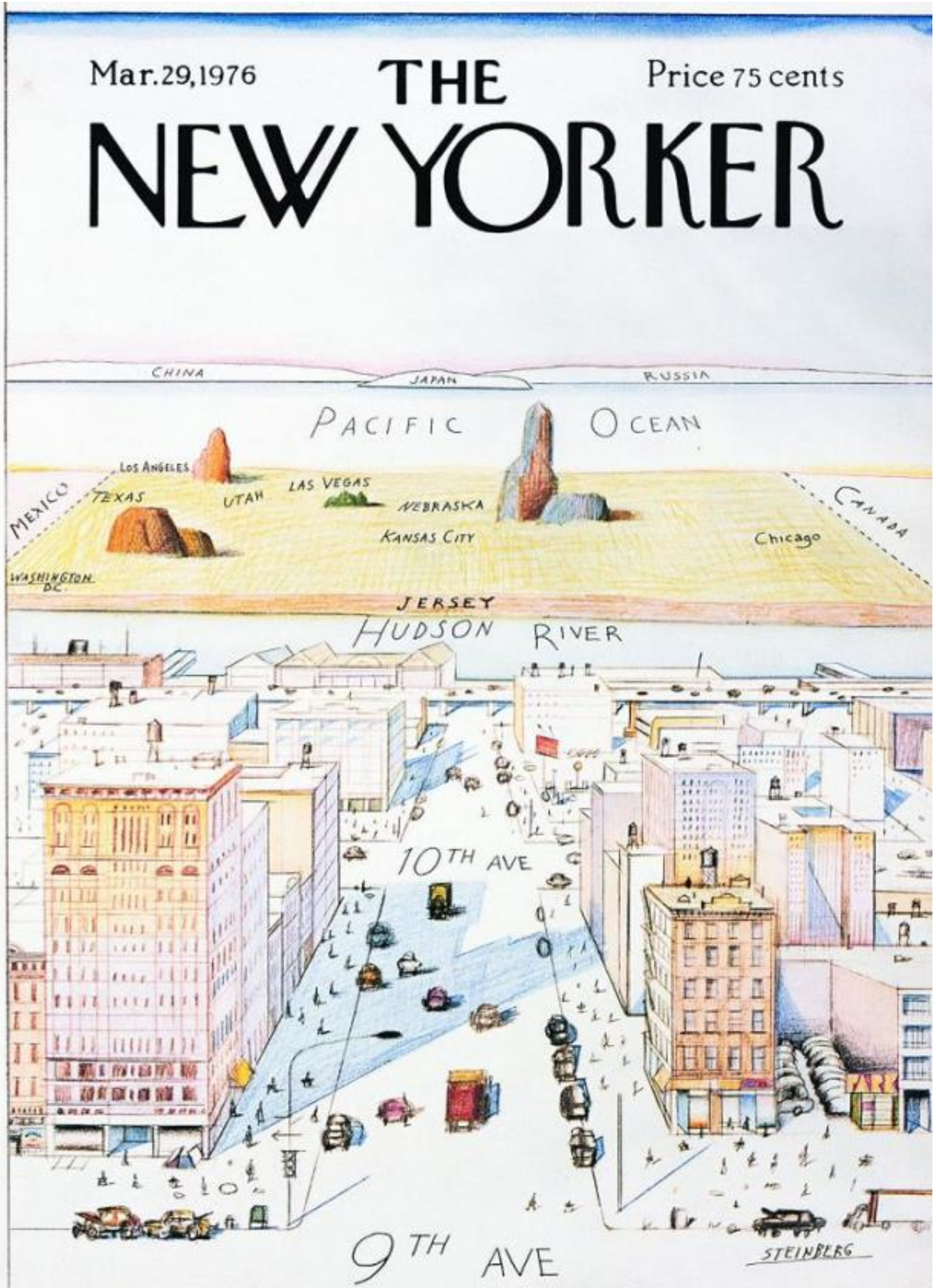
Simple Explanation

- Visual illusion is the result of the "interpretation" of the retina image by our brain.
  - Prior knowledge and experience
    - Hardwired or learned.
- We should consider what our eye can take *as well as* how our brain will process retina images.

Visual Perception

Visual Perception

- Based on sampled visual information
  - Need-to-know basis
- Optimization of resource allocation
  - Physical action
    - Eye movement, head movement.
  - Cognitive actions
    - Relying on working memory to retain visual images
    - Analyzing and interpreting visual images with the help of short-term and long-term memory.
- Goal-oriented
  - Intentionally or unintentionally
- What we see is a distorted version of the physical world.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Chicago
WASHINGTON DC.
JERSEY
HUDSON RIVER
10TH AVE
9TH AVE
STEINBERG

How to Decide What to "See"?

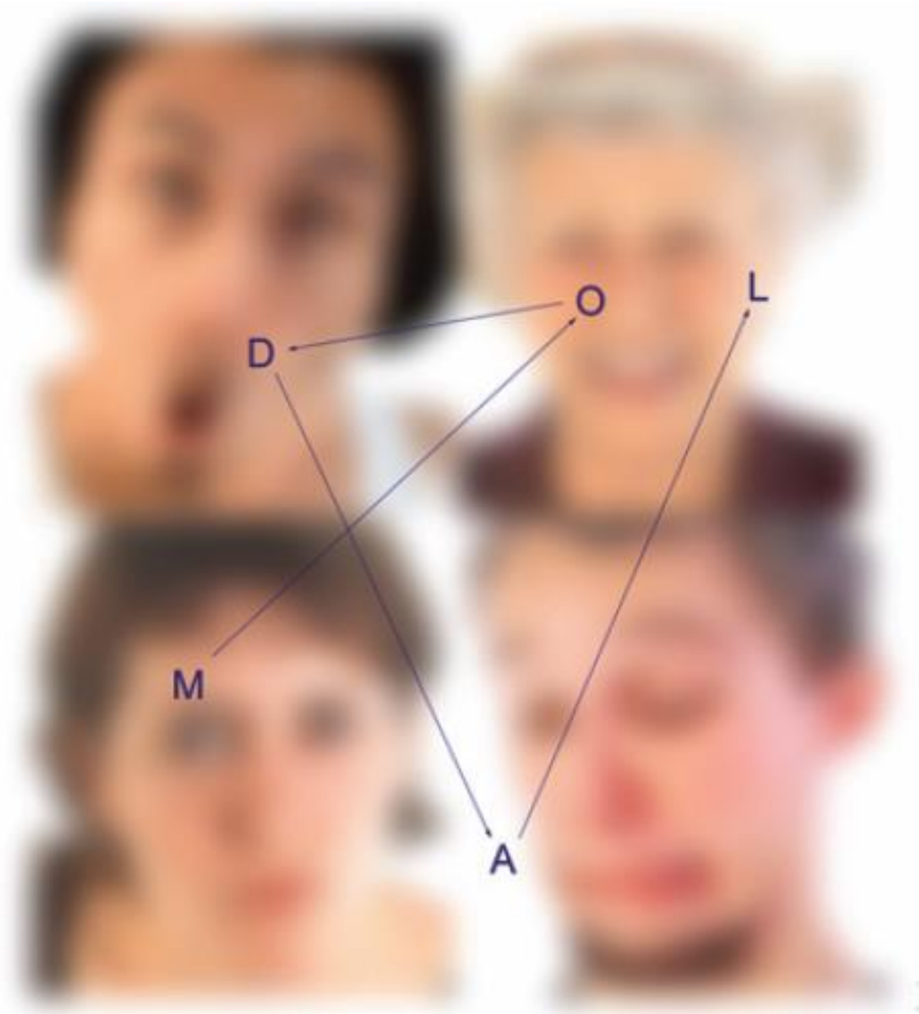
- Task-relevant.
  - What we are doing decides what we are "seeing".
- "Decision-making" process is optimized and hardwired in our brain.
  - Often out of our own control.
  - Unless intentionally.
  - Result of long-term evolution.

Working Memory

- One of key concepts that shape the foundation of theories on human information processing
- Scarce resources
  - Magic Number
    - 7 ± 2

Visual Search

- For features, patterns, and meanings
  - Hardwired
  - Learned: interpretation of visual images
    - Familiar vs. unfamiliar environments



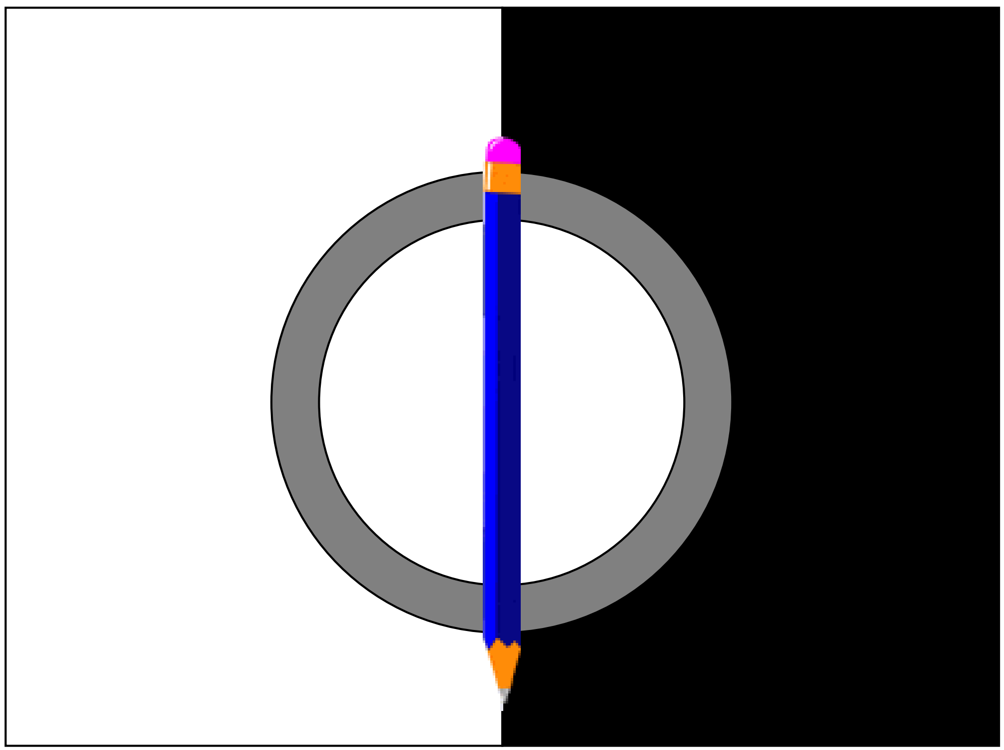
Goal-Driven

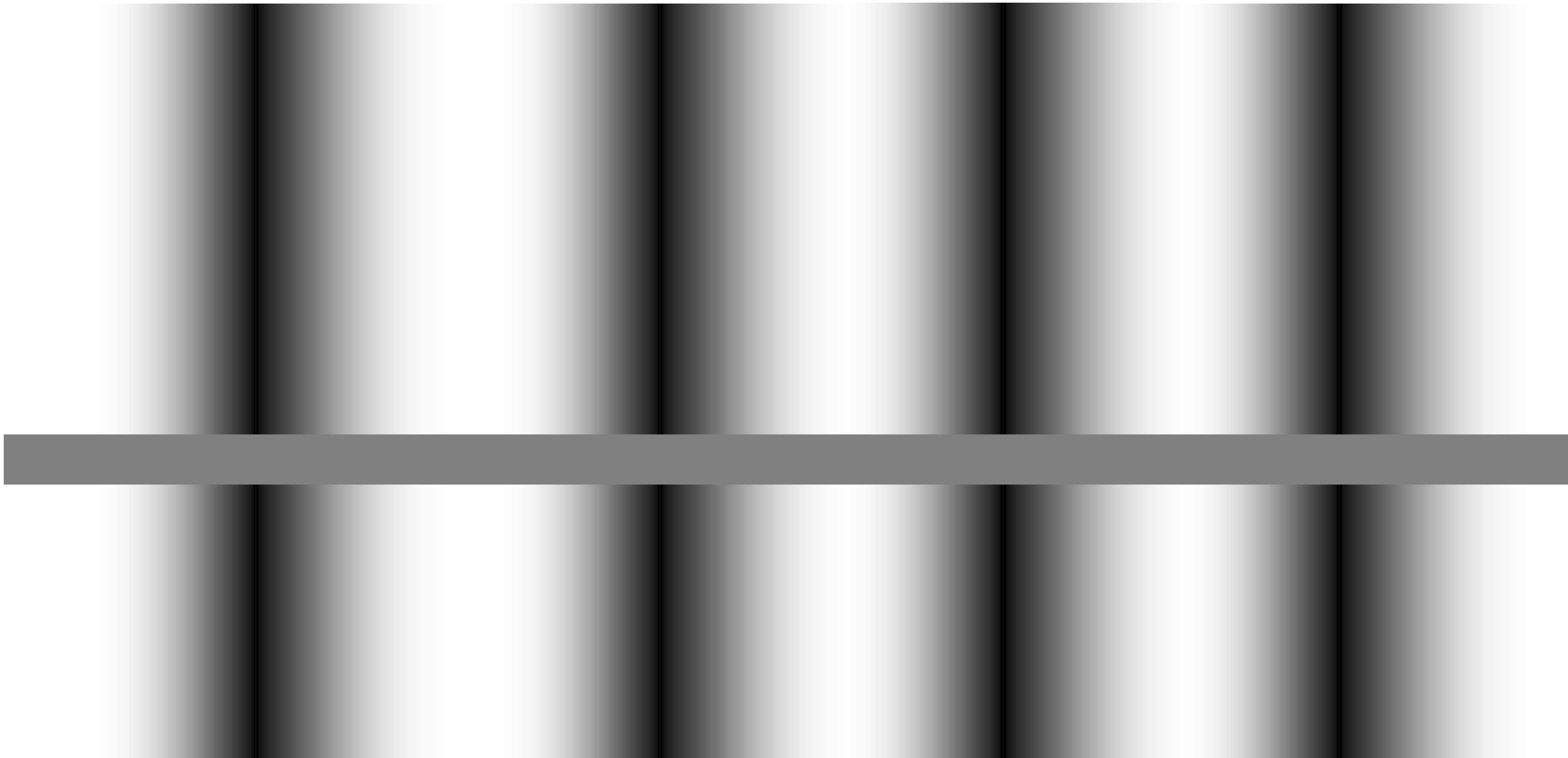
- The goal is usually predefined and with an action plan.
- Actions are often visually guided.
  - Eye movement
- Visual attention follows the action plan.
- Often very contextual.
  - Prior knowledge, training, etc.

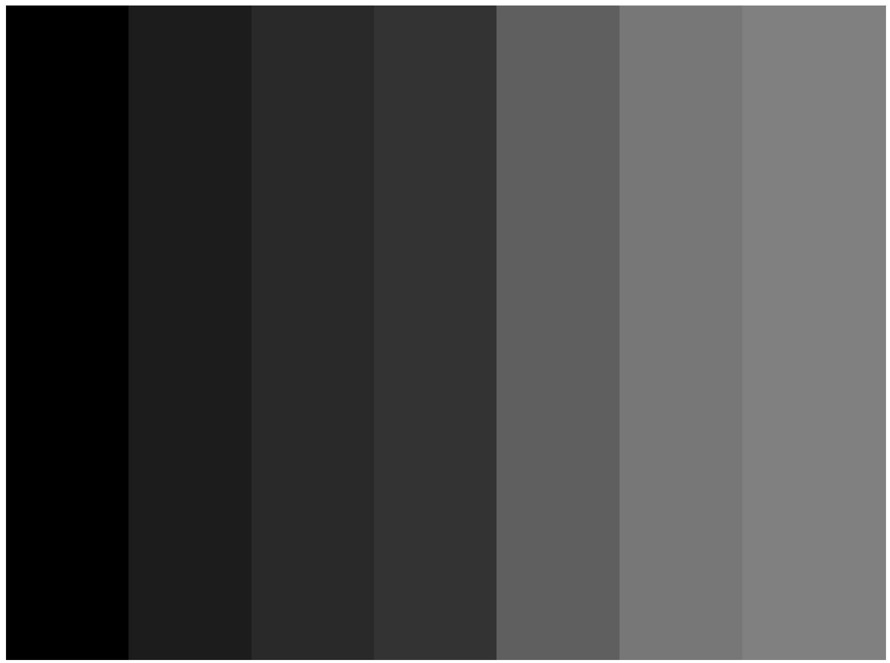
How affluent?

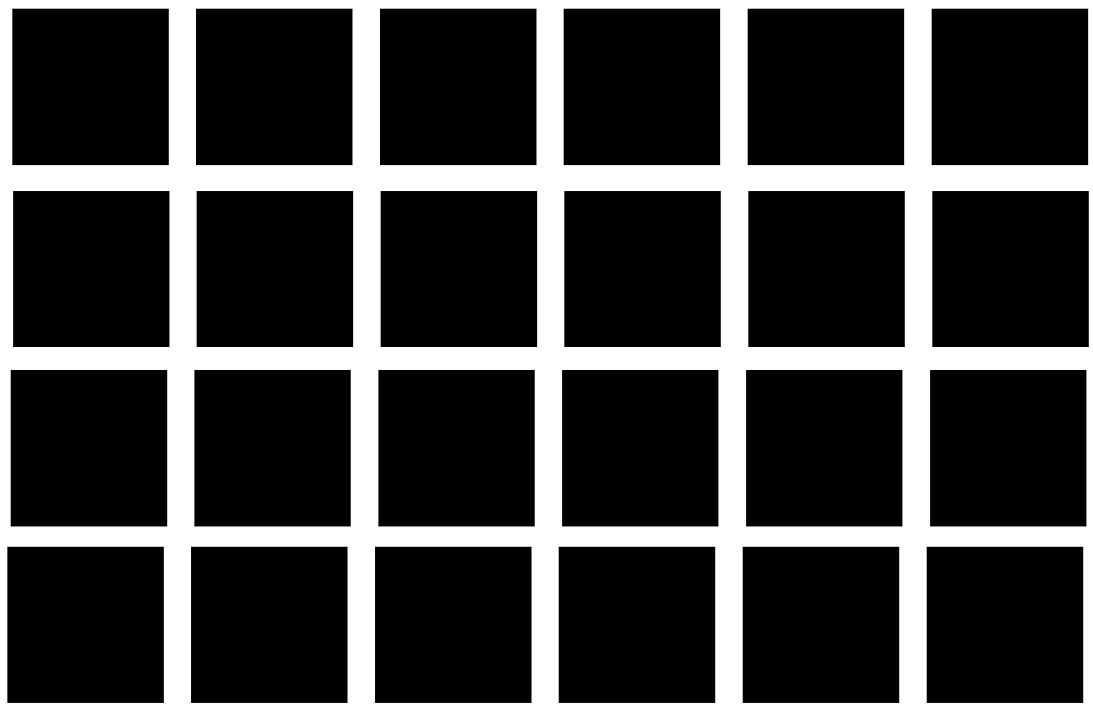
What are their ages?

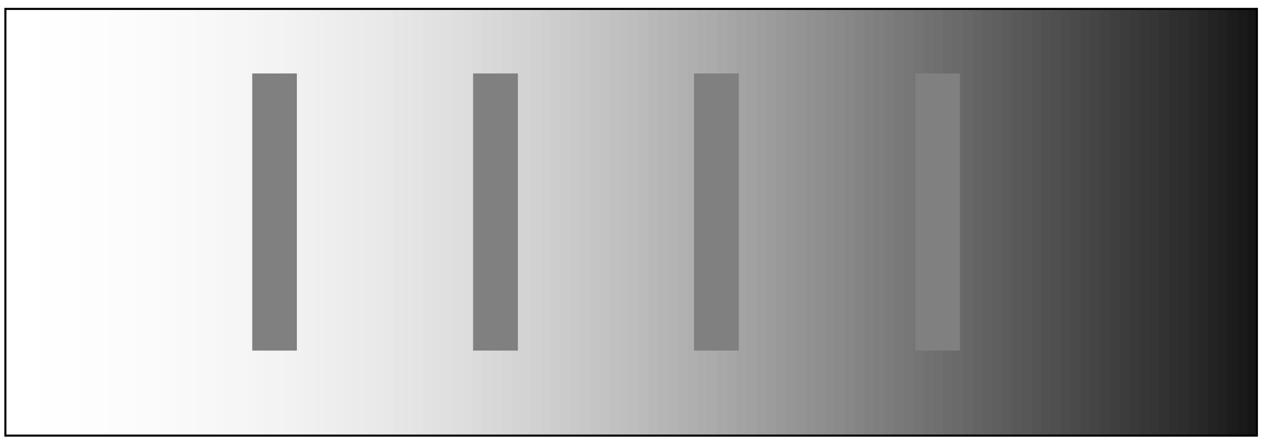
Understanding
Visual Perception through
Visual Illusions











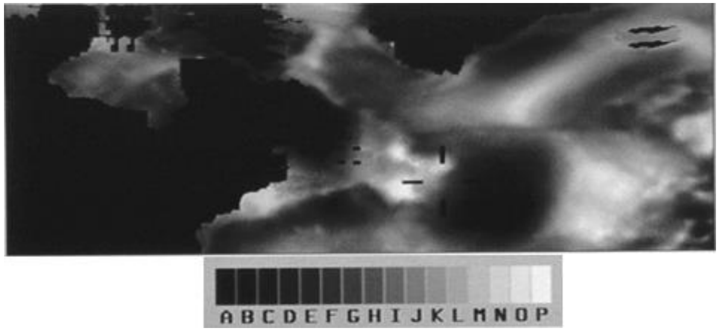
Perception of Lightness, Brightness, Contrast, and Constancy

Key Messages

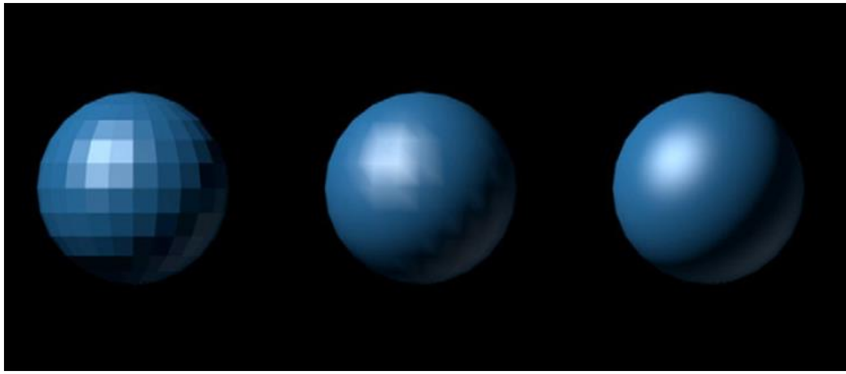
- Our eyes capture optical information from the external worlds, just as photo sensors do.
- However, our overall visual system, involving eyes and brain, is good at catching difference in luminance, rather than the absolute value of luminance.

Consequences on Visualization

- Errors in reading quantitative measures reflected in images
  – In particular, images filled with large areas of colors or gray scales

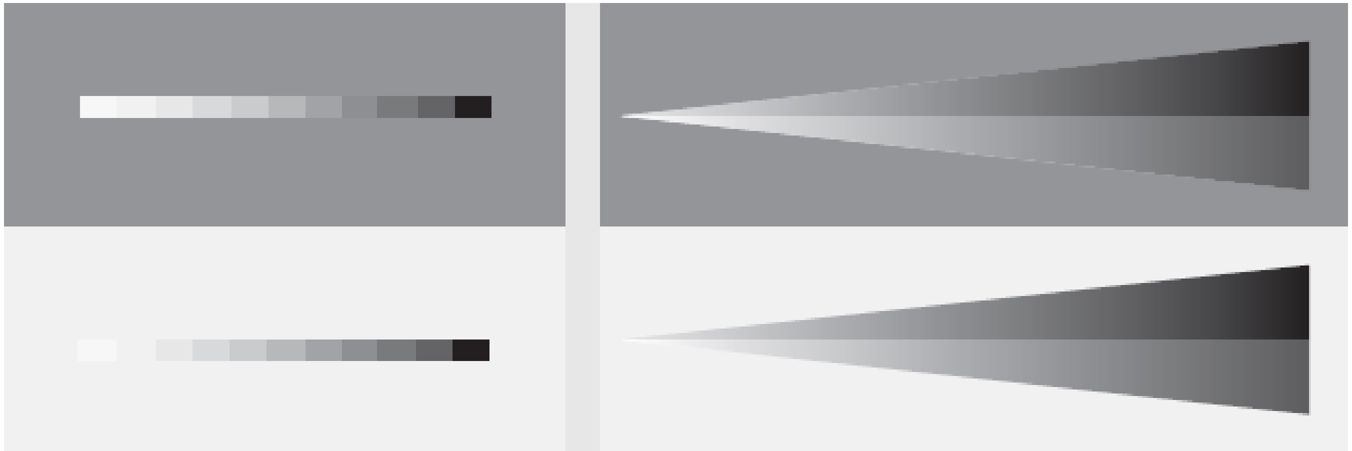


- Sensitive to object rendering



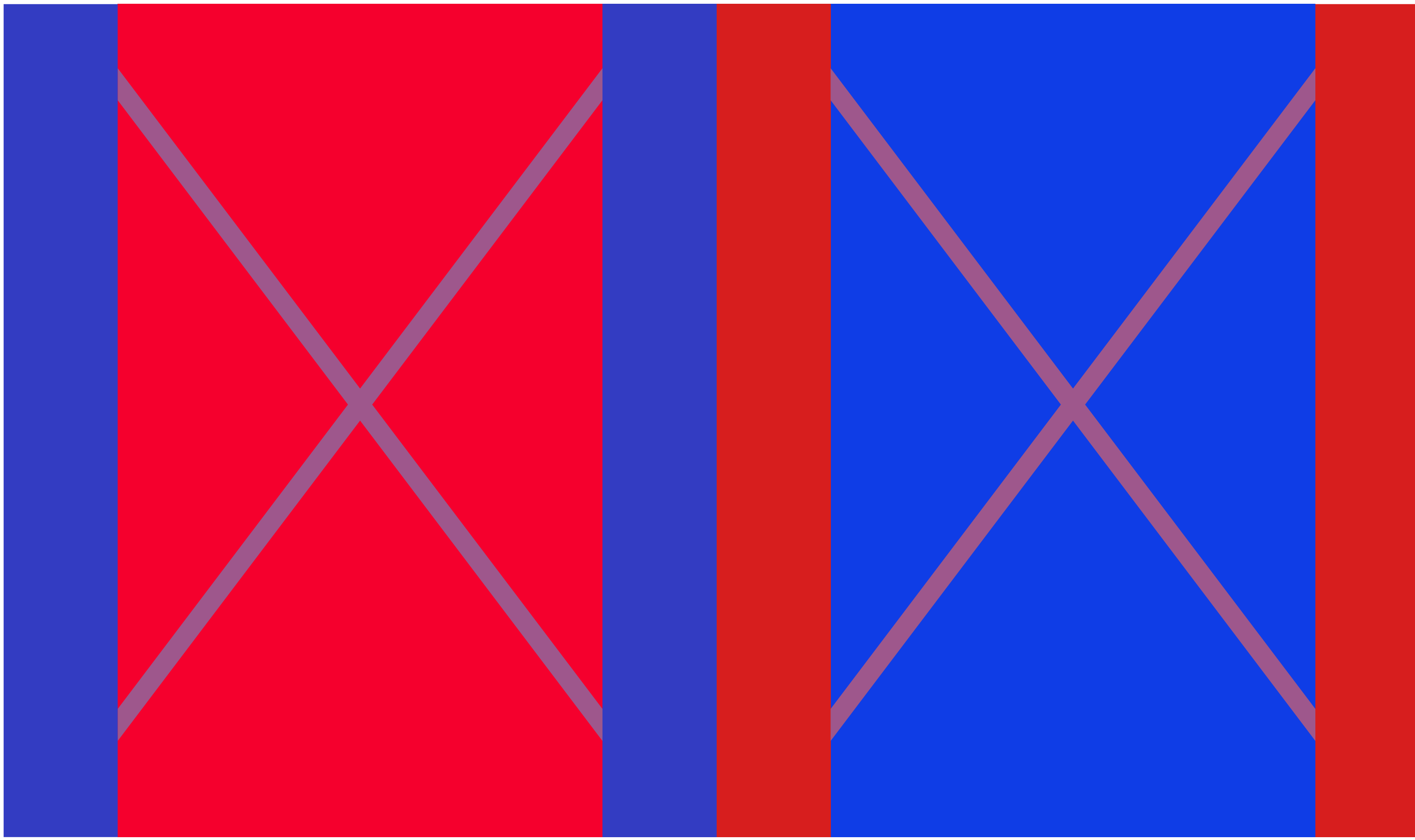
Consequences on Visualization (cont.)

- Edge enhancement



The top and bottom inner patterns are the same. Only the background is different.

More Pictures

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2 lbs.
Sierra
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2 lbs.
Yellowstone
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Gold
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Pine Needle
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1 lb.
Sandstone Buff
960/4
1.5 lbs.
Latte
6524
1 lb.
Mocha
6530
1 lb.
Willow
6567
Maple
6557
Camel
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Autumn
6557


Buckskin
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Doeskin
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Dark Buff
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3 lbs.
Fawn
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.5 lb.
Boulder
6567
1 lb.
Cinnamon
1300
1 lb.
Mission
130
Terra Cotta
110
Coral Red
130

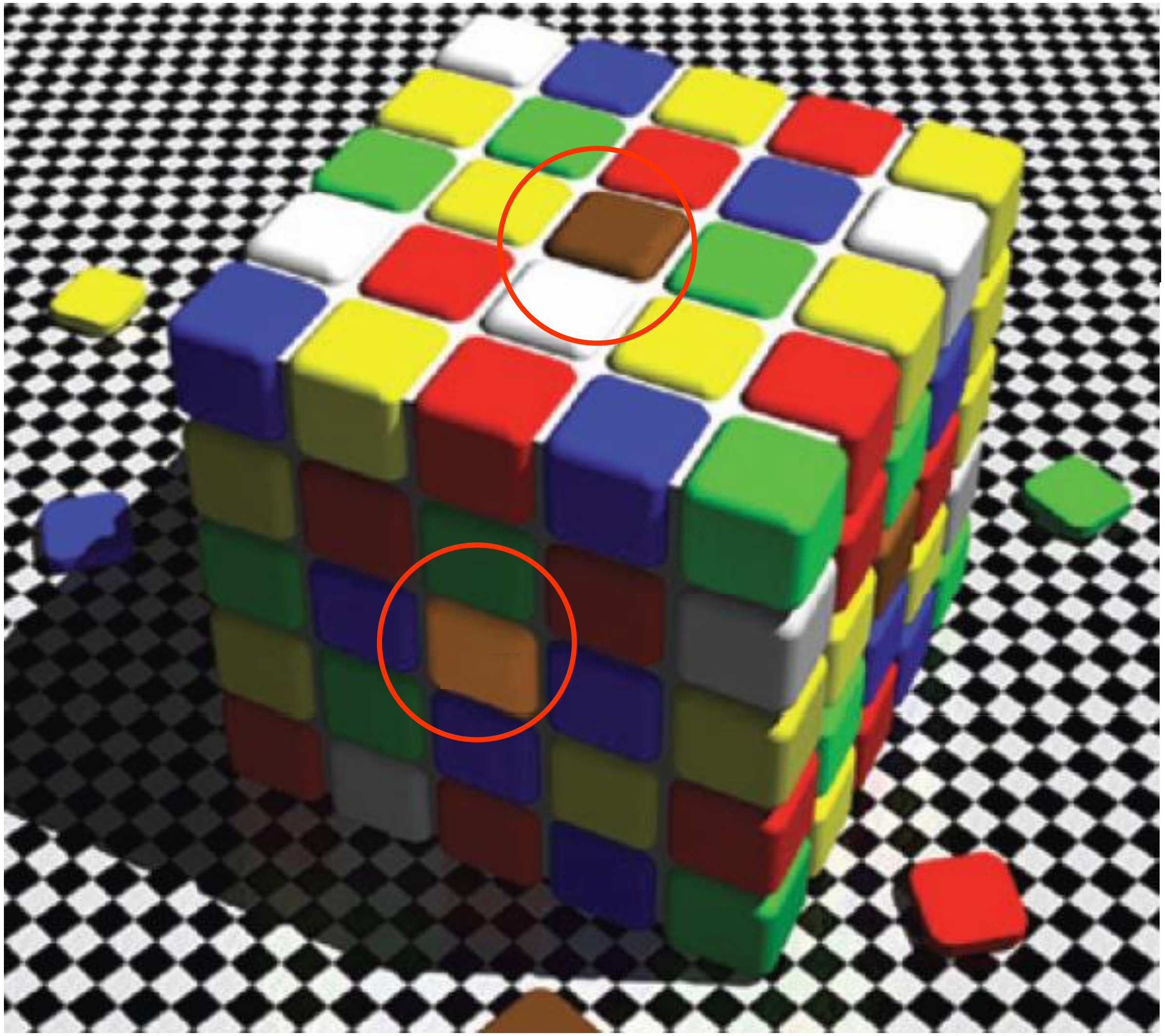
Perception of Colors

Chromatic Contrast

- More complex and harder to predict

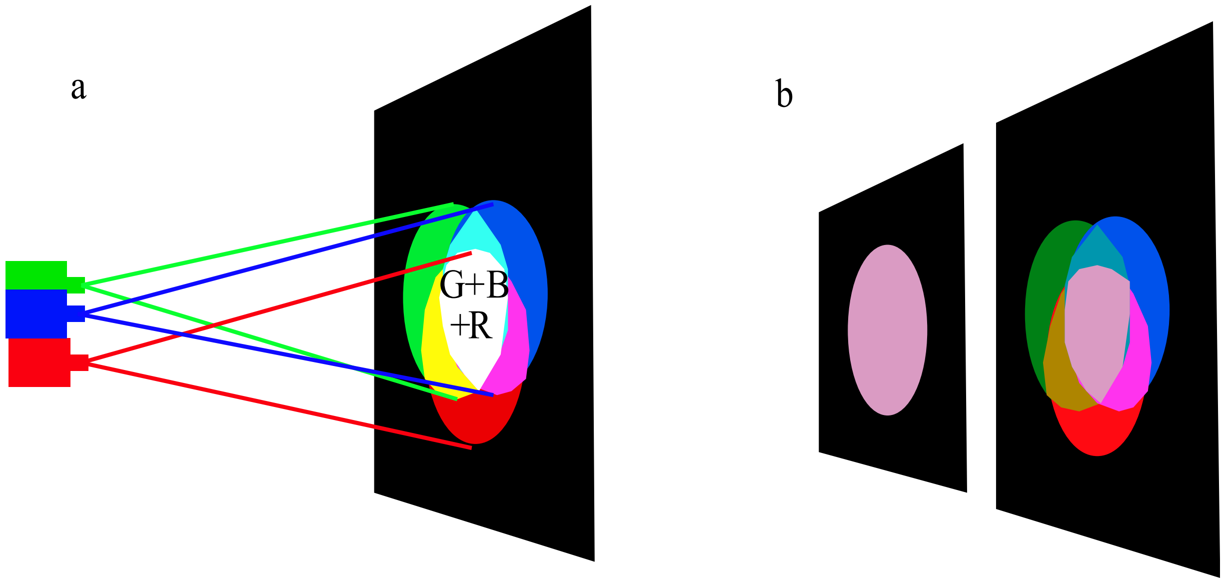
Color Appearance

- Color is seen in context.
  - Can be affected by surrounding colors.



Trichromacy Theory

A three primary system



Consider three lamps

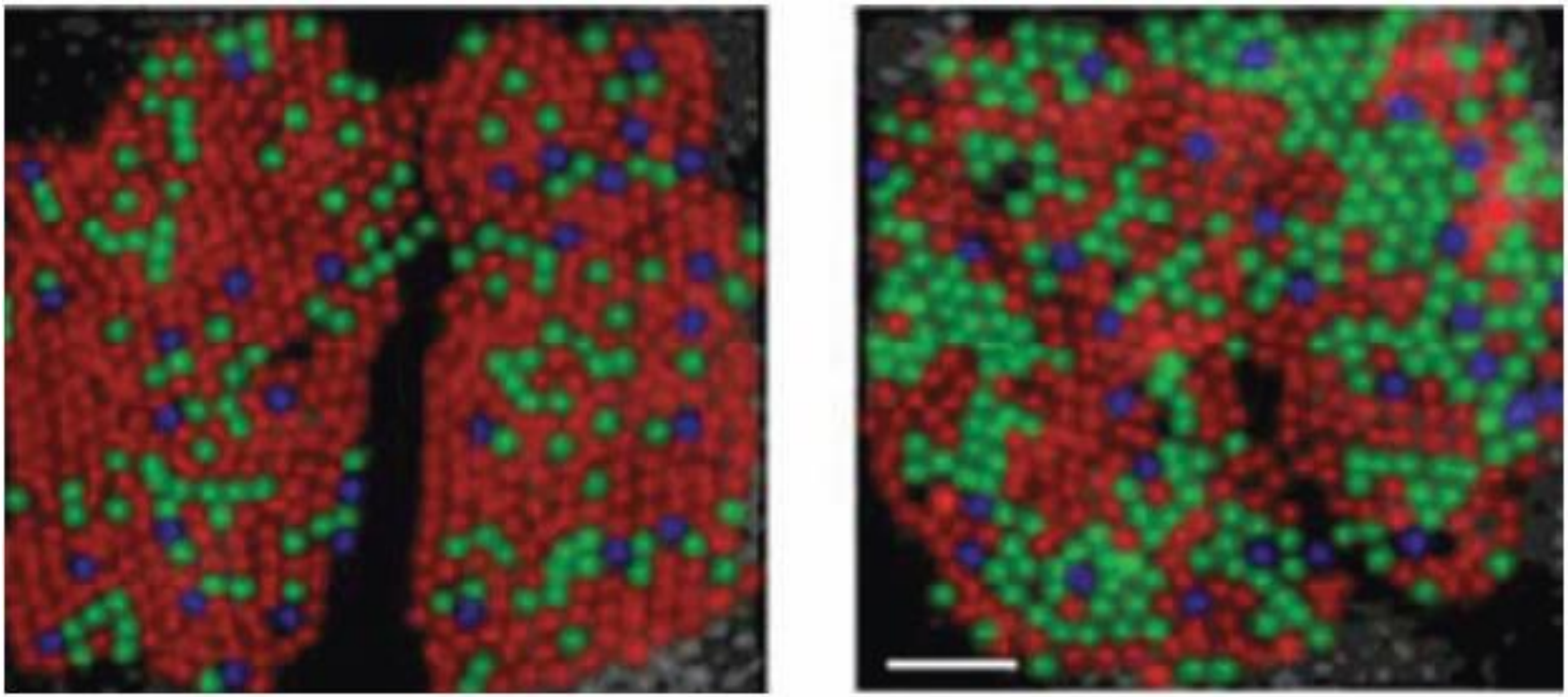
Opponent Process Theory

- Color-opponent channels.
  - Information from different types of sensors is processed to deliver perceived color and luminance.
  - We have different channels for colors.
    - Red-green, yellow-blue, black-white

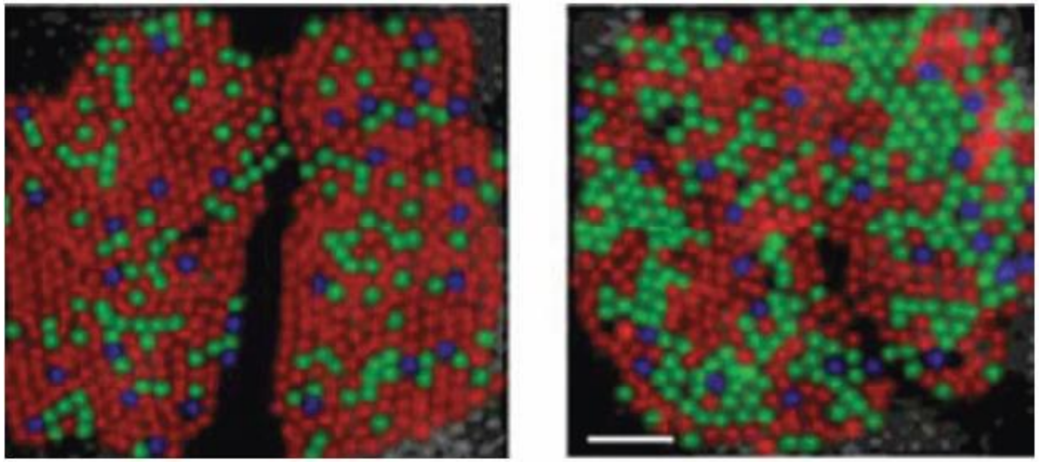
Something About Our Eye

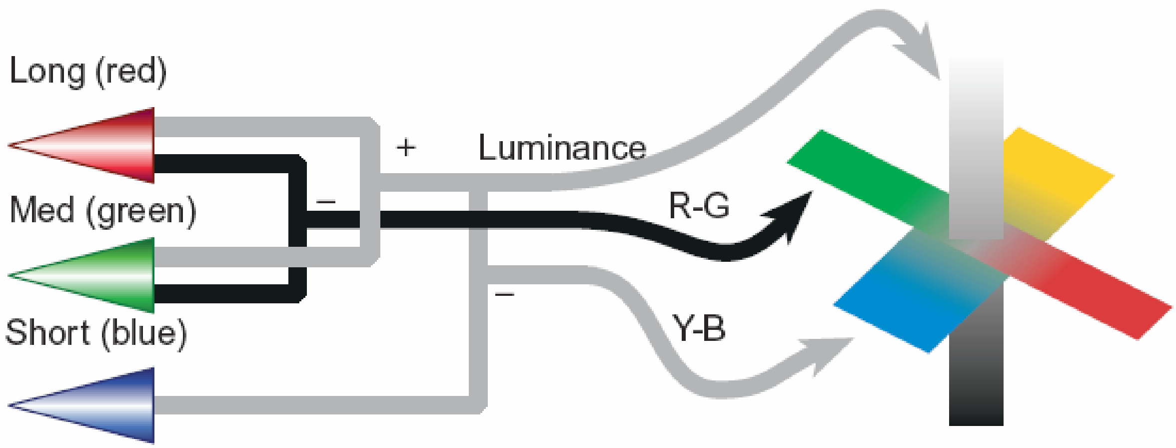
Cones and Rods

- Two types of photoreceptors on retina
  - Cone receptors: 6-7 million
    - Used for normal daytime vision
    - Three types:
      - Short-wavelength
      - Middle-wavelength
      - Long-wavelength
  - Rods receptors: 120 million
    - Used for very low light levels
    - Become less important in modern life.



Opponent Process Theory



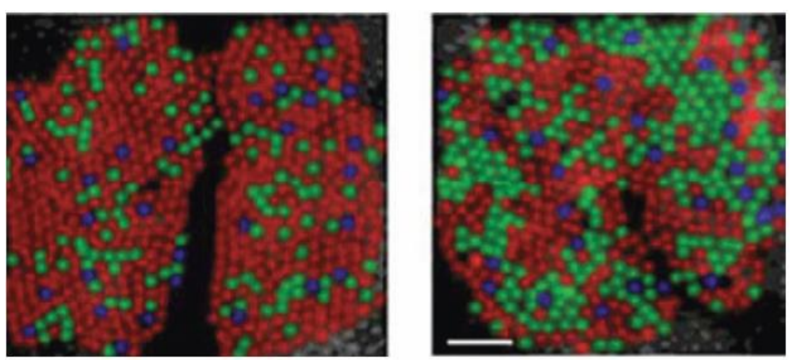


Black and White Is the Best.

Some natural philosophers
Suppose that these colors arise from the accidental vapours diffused in the air, which communicates their own hues to the shadow

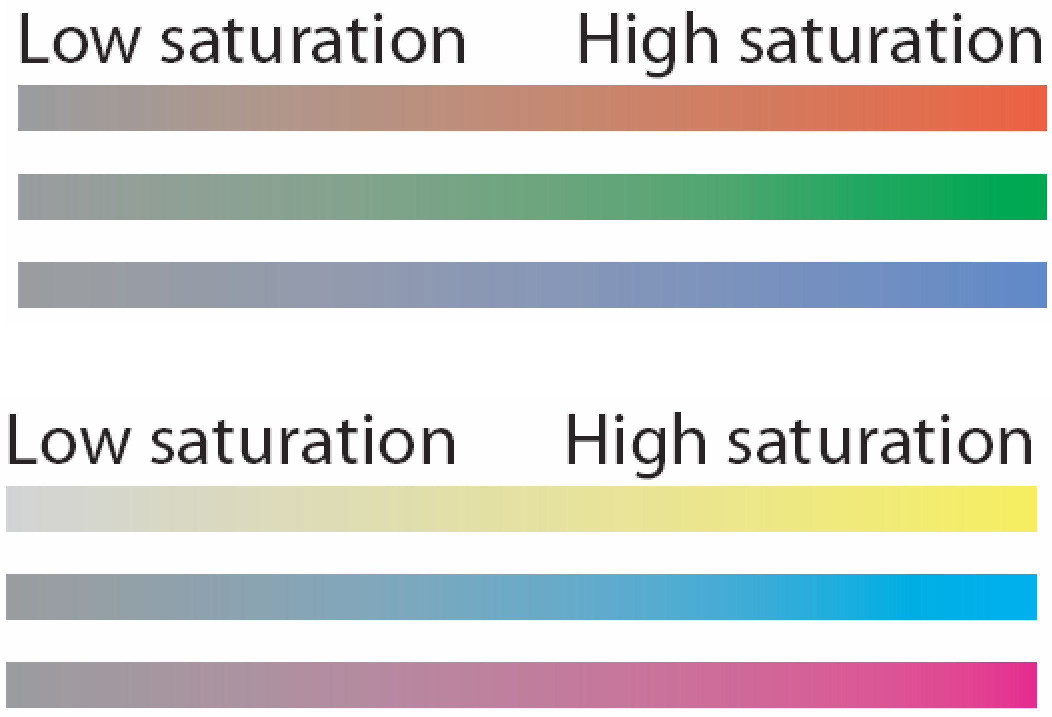
Some natural philosophers
Suppose that these colors arise from the accidental vapours diffused in the air, which communicates their own hues to the shadow

- Black and white
  - Only require two types of cones
    - They are distributed widely.

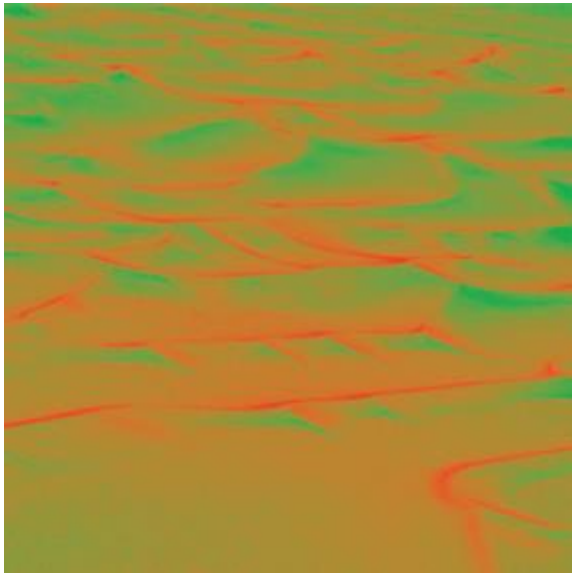


Color Saturation

- Signal strength

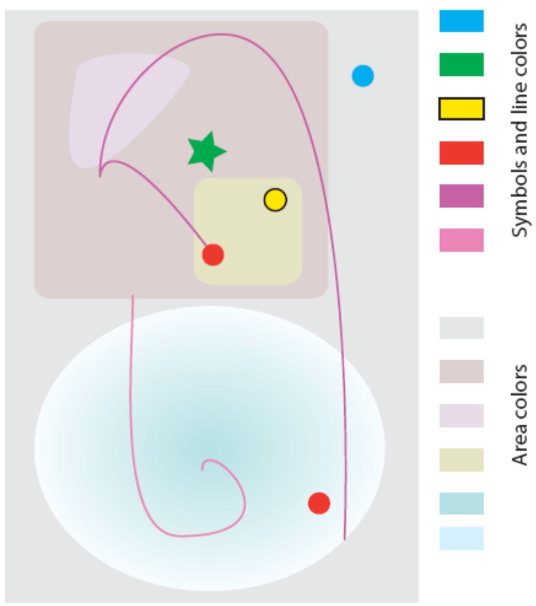


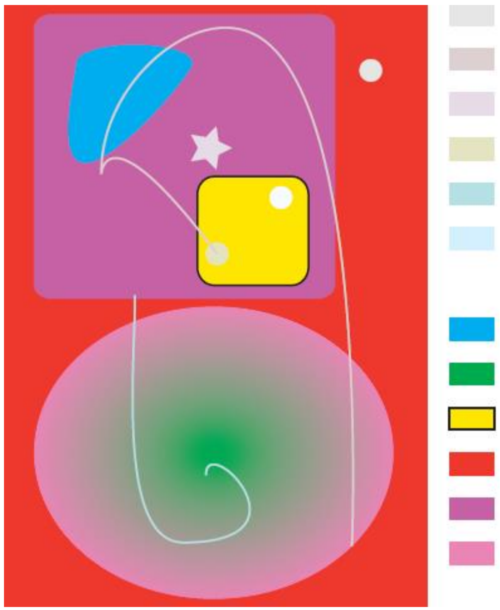
Using Colors Carefully

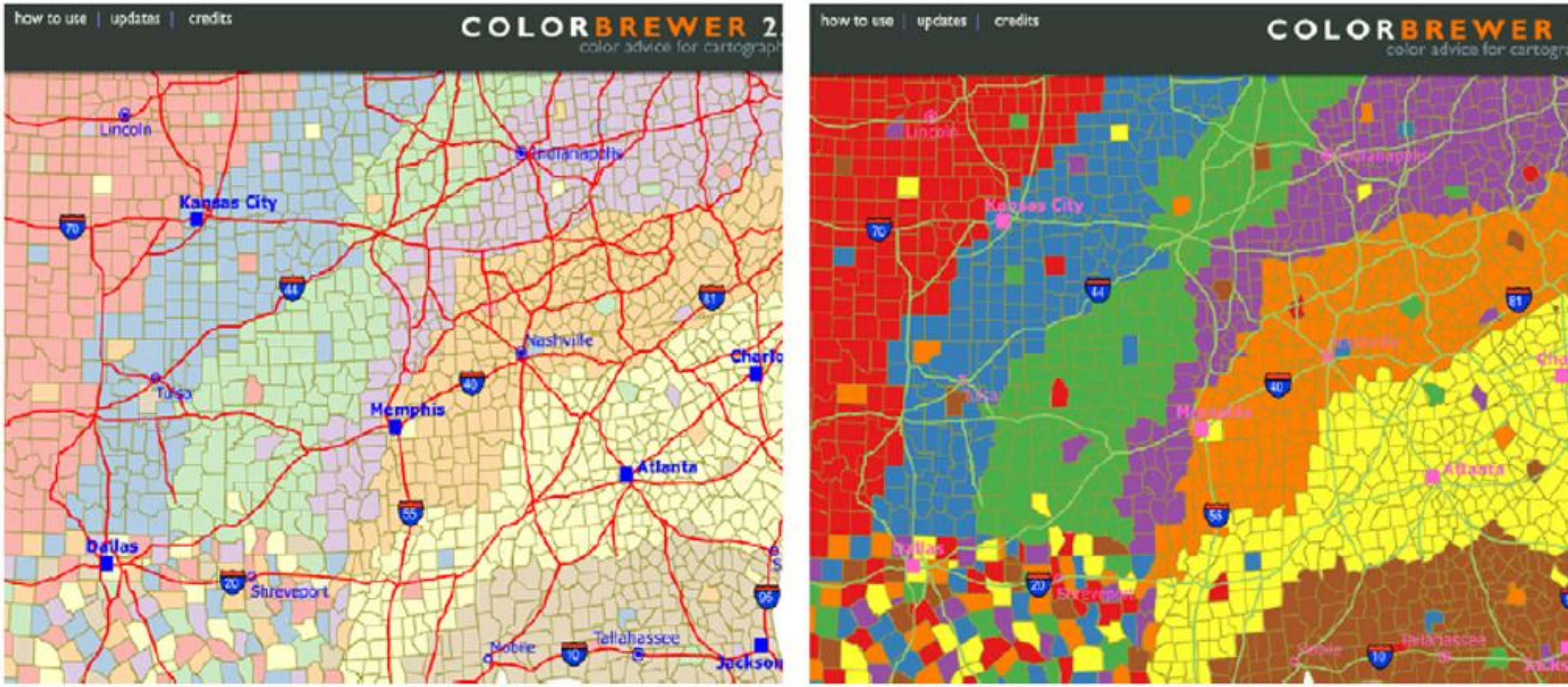


Large and Small Areas

- Small areas of interest: saturated colors.
  - Background colors: less saturated.



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Atlanta
Tallahassee

Emphasizing and Highlighting

- Using a different color is sometimes not enough.

(a) Higlighting text by changing the characters must be done using high saturation colors that contrast with the background.

(b)

```
import java.applet.Applet;
import java.awt.Graphics;
import java.awt.Color;

    public class ColorText extends Applet
{
    public void init()
    {
            red=100;
            green=255;
            blue=20;
    }
    public void paint (Graphics g)
    {
            Gr.setColor(new Color(red, green, blue));

            Gr.drawString("ColoredText". 30,50);
    }

    private int red;
    private int green;
    private int blue;
}
```

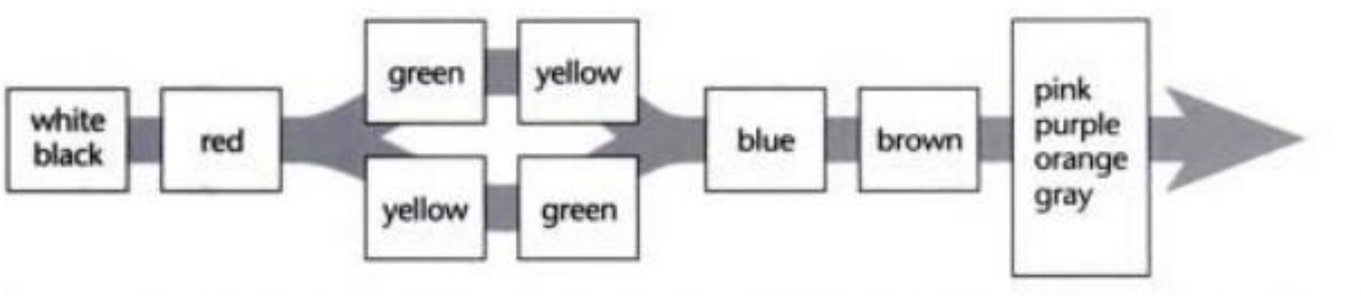
Color Coding

- Using colors to distinguish object types
  - Learnability
    - Using the unique hues first
      - Red, green, yellow, blue
    - Limited number of different colors.

Unique Hues

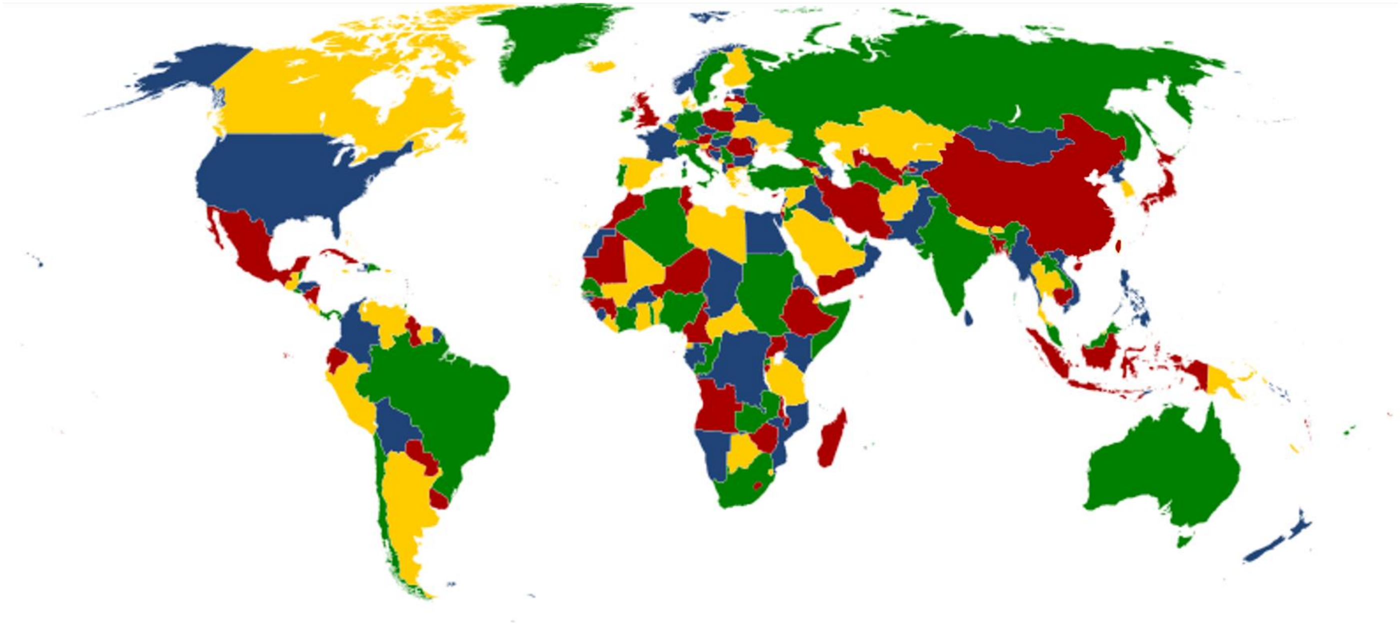
- Six basic colors

- Cross-Culture Names



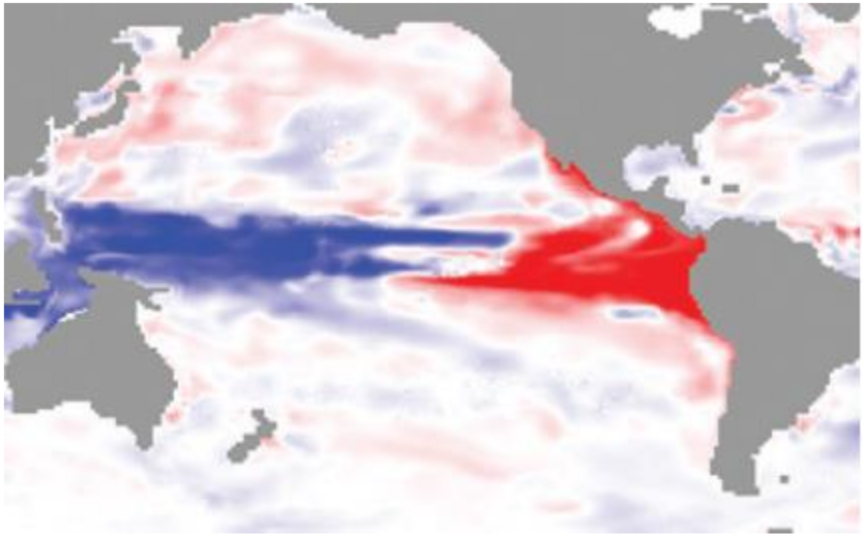
Area Distinction

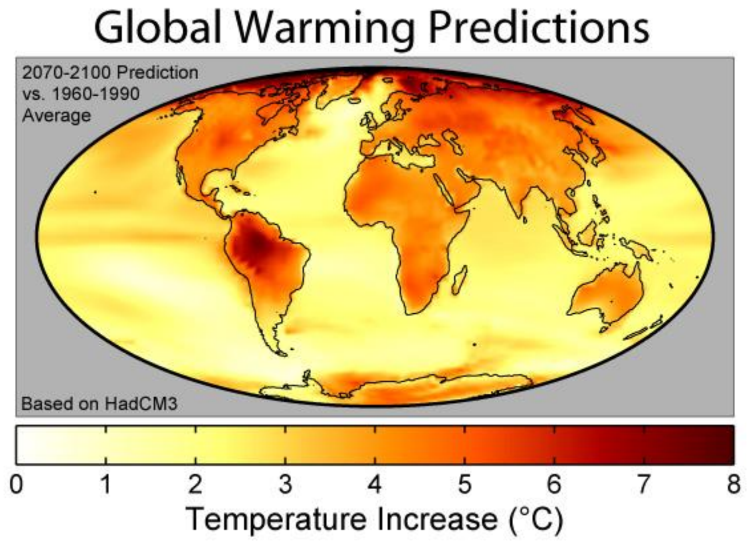
- Using different colors is good enough.
  - Labeling (e.g., Four-color theorem)



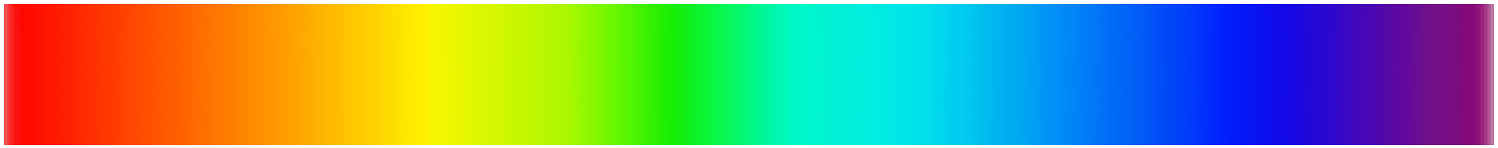
Color Sequences

- Often used on maps
  - Showing the shapes
  - Comparing phenomena quantitatively.

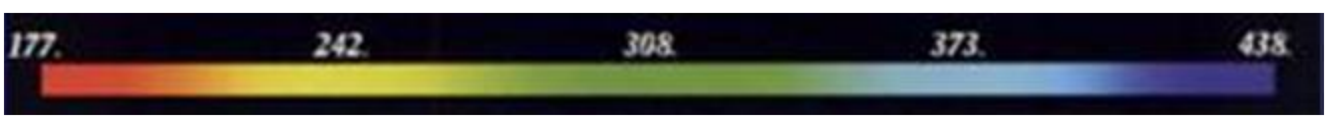




Spectrum Sequence

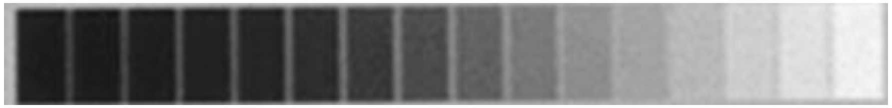


- The whole spectrum sequence is not perceptually ordered.
  - Part of the spectrum could be.
- Provide color keys.
  - Ordering colors according to their luminance.

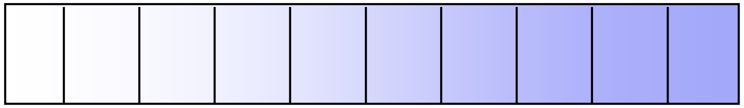


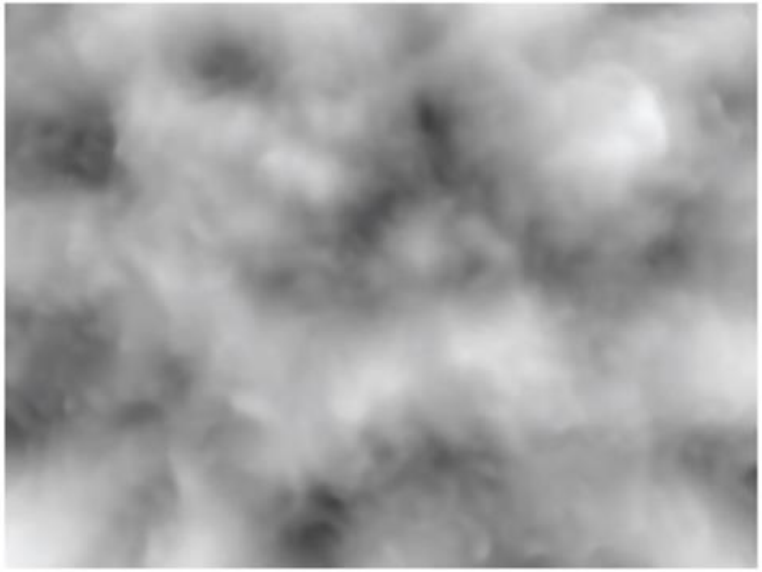
Quantitative Comparison

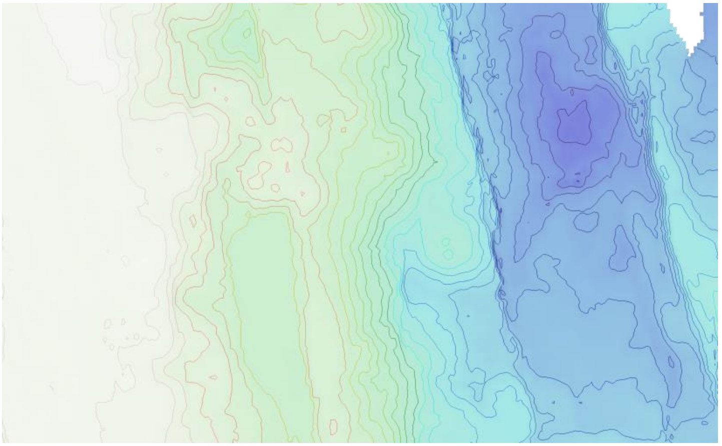
- Perceptually ordered colors
  - Grayscale

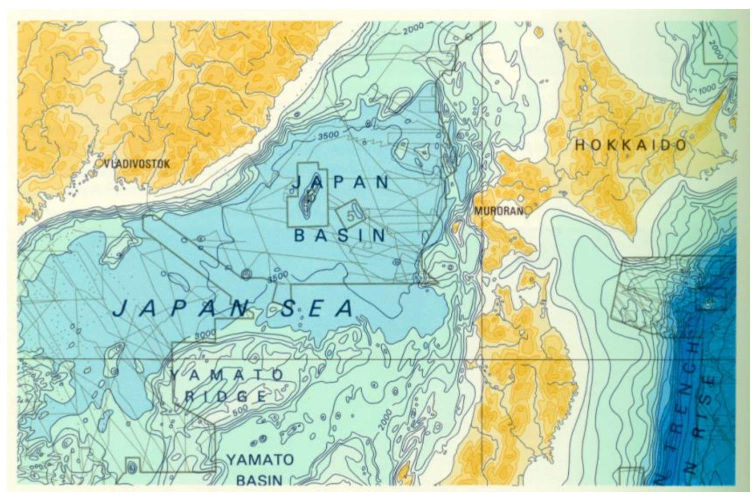


  - Same color, different saturations





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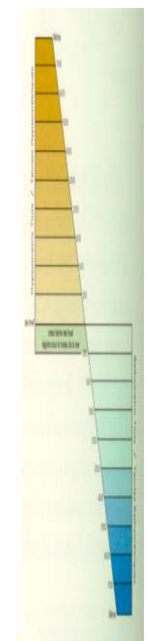
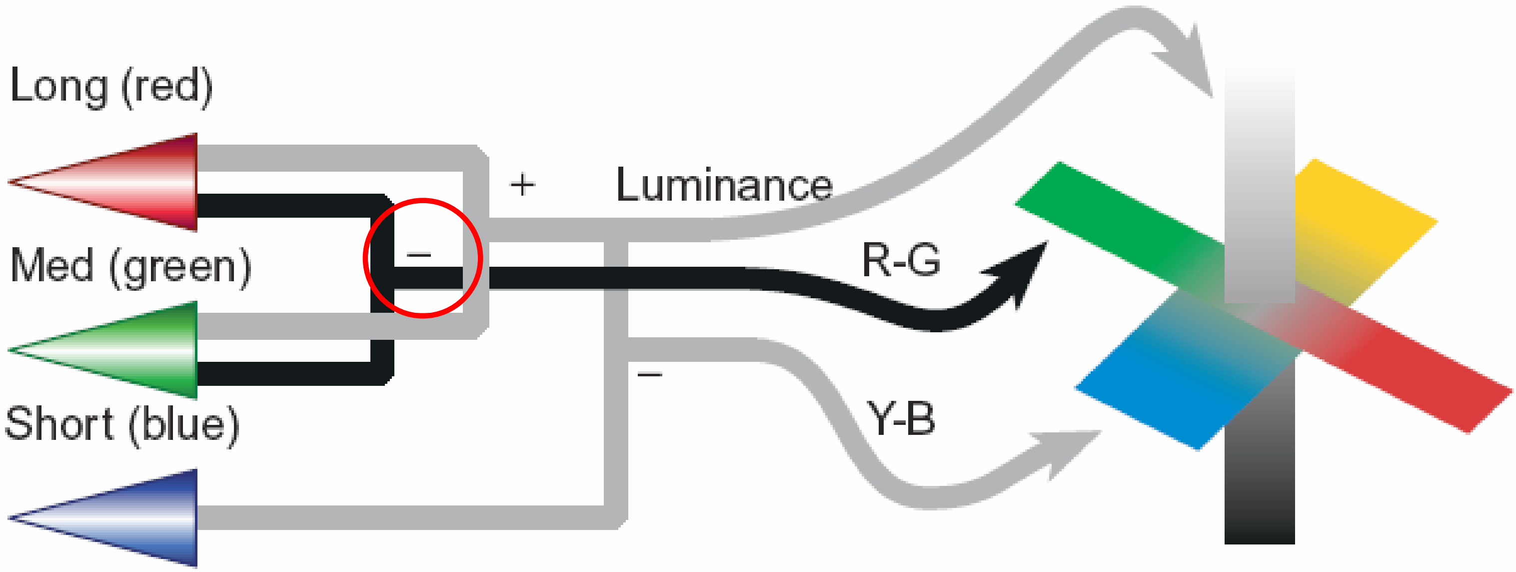
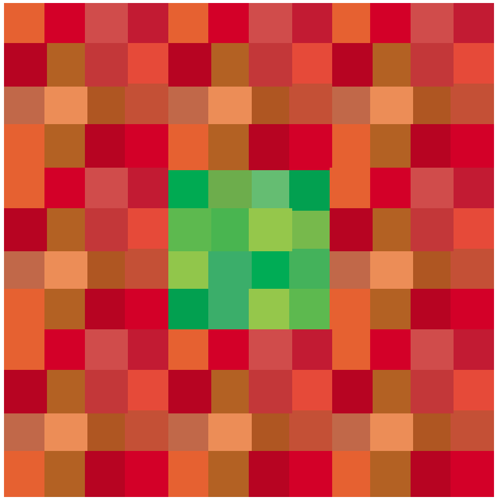
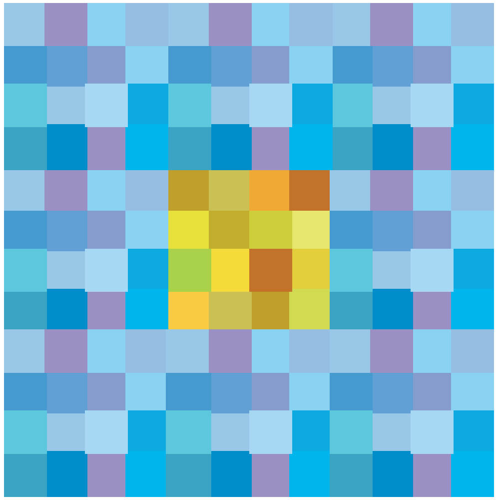
1000
500



Color Blindness







Semantics of Color

- Could be culture-dependent



Group Project

- Progress report 1 to describe your plan
- Four sections
  - Introduction, Data, Tasks and Visualization, Collaboration Plan

- See the description and requirements on CANVAS