



# The Usage of Colors

Computer Graphics and Visualization

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# Colors in Computer Graphics

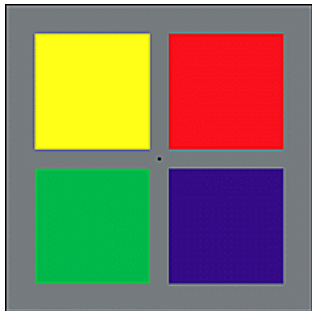
- ▶ Color is a powerful and attractive aspect of our experience of the world.
- ▶ Color shapes our perception, interpretation and memory of everything we see.
- ▶ In computer graphics, careful use of colors helps to get the message across

# Visual Communication

- ▶ Colors used well can enhance the effectiveness of a message.
- ▶ Effective use of colors depends on:
  - human factors.
  - which context the audience views the display.
- ▶ No strict rules for the use of colors.

# Color Vision

- ▶ Avoid using strong red and strong blue adjacent to each other.
- ▶ Never display fine detail using the blue channel alone.
- ▶ Don't use hue alone to encode information.



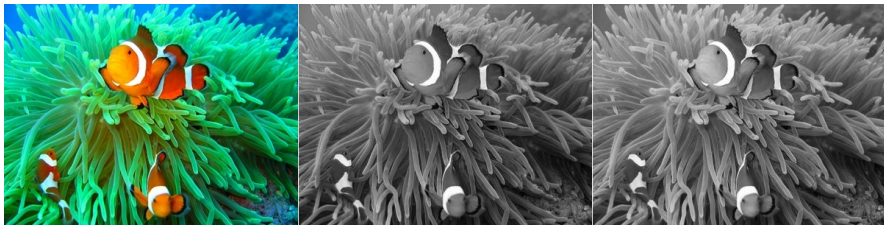
# Color Luminance

- Differences used in converting to gray scale

$$Y = 0.3R + 0.59G + 0.11B$$

white	R	G	B	100%
yellow	R	G		90%
cyan		G	B	70%
green		G		60%
magenta	R		B	40%
red	R			30%
blue			B	10%
black				0%

# Color Luminance



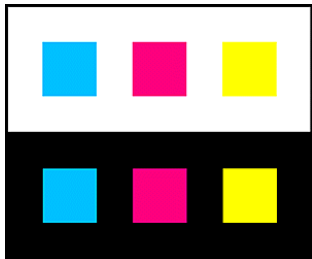
# Color Perception

Colors tend to look:

- ▶ darker and smaller against white,
- ▶ lighter and larger against black.

Surrounding colors can cause a colored region to look tinged.

- ▶ Enrich a display in art and design, BUT can cause viewers to see differently than the designer intended.



# Color Blindness

- ▶ **Protanopia** (1% of males): Lacking the long-wavelength sensitive retinal cones. Green-yellow-red are hard to separate. A cyan-like wavelength around 492 nm looks white. The brightness of red, orange, and yellow are reduced.
- ▶ **Deuteranopia** (1% of males): Lacking the medium-wavelength cones. Green-yellow-red section are hard to separate. of the spectrum. A cyan-green-like wavelength around 498 nm looks white. No dimming of reds. Purple colors all these appear similarly.
- ▶ **Tritanopia** (less than 1% of males and females): Lacking the short-wavelength cones. Short-wavelength colors (blue, indigo and a spectral violet) greenish are drastically dimmed. Yellow looks the same as pink. Purple colors looks as shades of red.



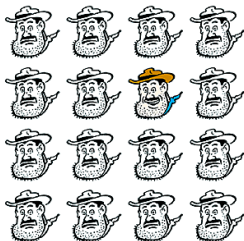
# Color Effects

- ▶ A little color can be more effective than a lot.



# Colors in Computer Graphics

- Color can draw attention to an item



- Color can change the meaning

**Color** is one of the most effective visual attributes for **coding** information in displays and **is** capable, when used correctly, of achieving **powerful** and memorable effects.

# Color Associations

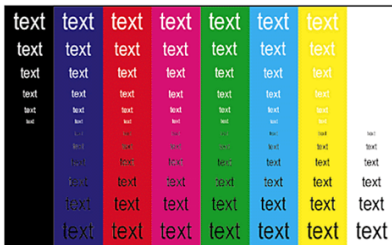
Color	Positive Associations	Negative Associations
Red	Passion, strength, energy, heat, love	Blood war fire danger, anger, aggression
Green	Nature, fertility, safety, environment	Inexperience, decay, envy, misfortune
Yellow	Sun, summer, gold, harvest, optimism	Cowardice, treason, hazard, illness, folly
Blue	Sky, sea, stability, peace, unity, depth	Depression, obscenity, passivity
White	Purity, peace, cleanliness, innocence	Cold, clinical, surrender, sterility, death
Gray	Intelligence, dignity, restraint, maturity	Fear, void, night, secrecy, evil, anonymity

# Text

- ▶ Luminance contrast between foreground and background should be a minimum of 3:1 and preferably at least 10:1.
- ▶ Highest contrast: black or blue on white or yellow and vice versa.
- ▶ Red, green and magenta more difficult to read.
- ▶ Avoid colored text on colored background where legibility is important.

## Legibility and Font Size

- ▶ Effect of text and background color on legibility.
- ▶ Effect of text color and size on legibility.



# Colors in Computer Graphics

Nominal color coding:

- ▶ unique color codes to different parts
- ▶ not indicating differences in value, order or priority
- ▶ limit to seven or fewer colors

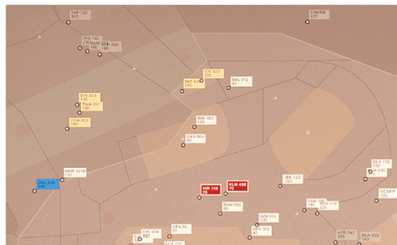
Ordinal color coding

- ▶ graded sequence of colors to represent the value of one or more variables.

Include a color key or scale.

# Color Coding

- ▶ Nominal color coding
- ▶ Ordinal color coding



# Color Coding

- ▶ Don't use color that does not support or add to the meaning of the information displayed.
- ▶ Use colors that enable the user to interpret the meaning of the information displayed.
- ▶ In modeling applications, use only enough color to create a realistic effect.



# Color Coding

Using colors effectively is complicated.

- ▶ Many different factors influence how the color will be seen.
  - type of display device.
  - the viewing environment.
  - the visual capability of the user.
  - the task and application requirements.
  - position of other graphical windows and displays.

There is no easy formula that will work in all circumstances.