Representation and Blending of Images

LESSON 11

Computer Graphics 1

Image Representation

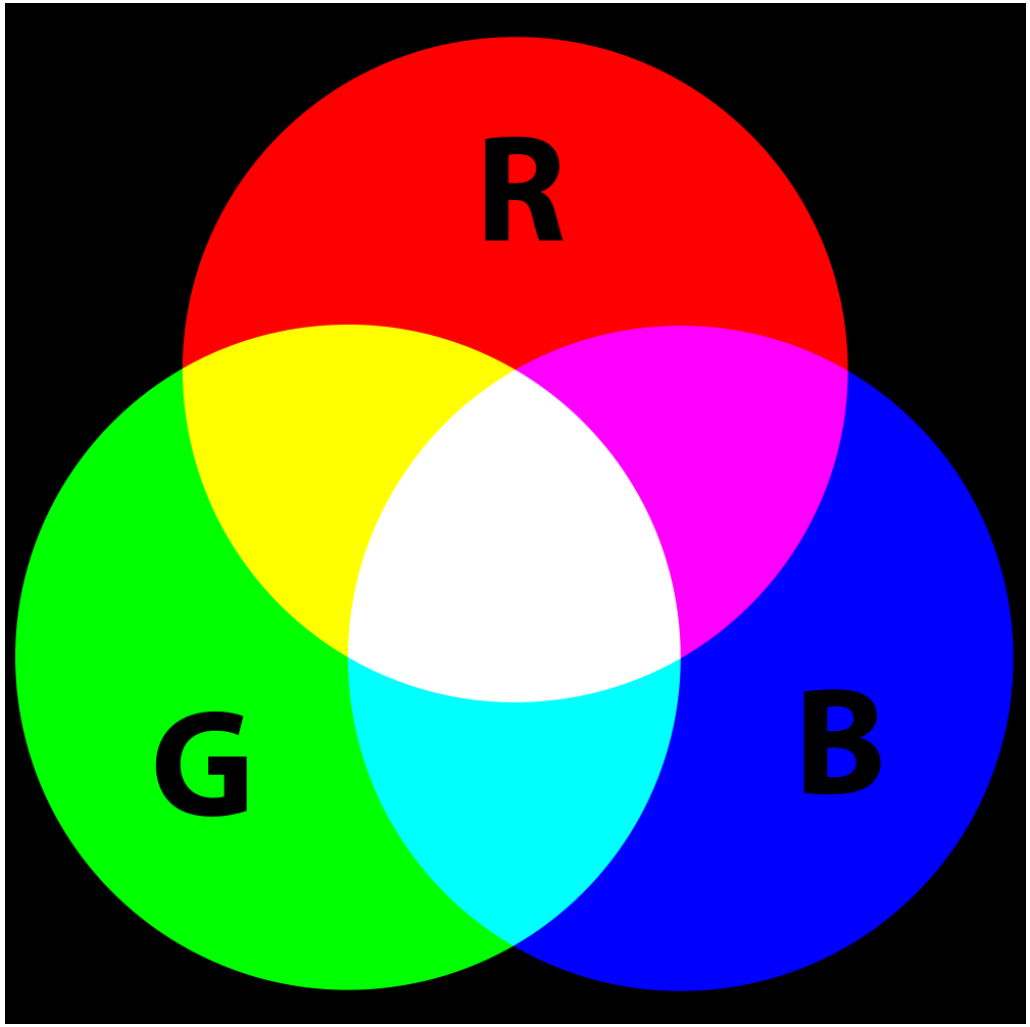
Color models

Color Models

- Abstract mathematical model describing the way colors can be represented as tuples of numbers
- Example
  - RGB, CMYK, …
- Why do we need multiple color models?

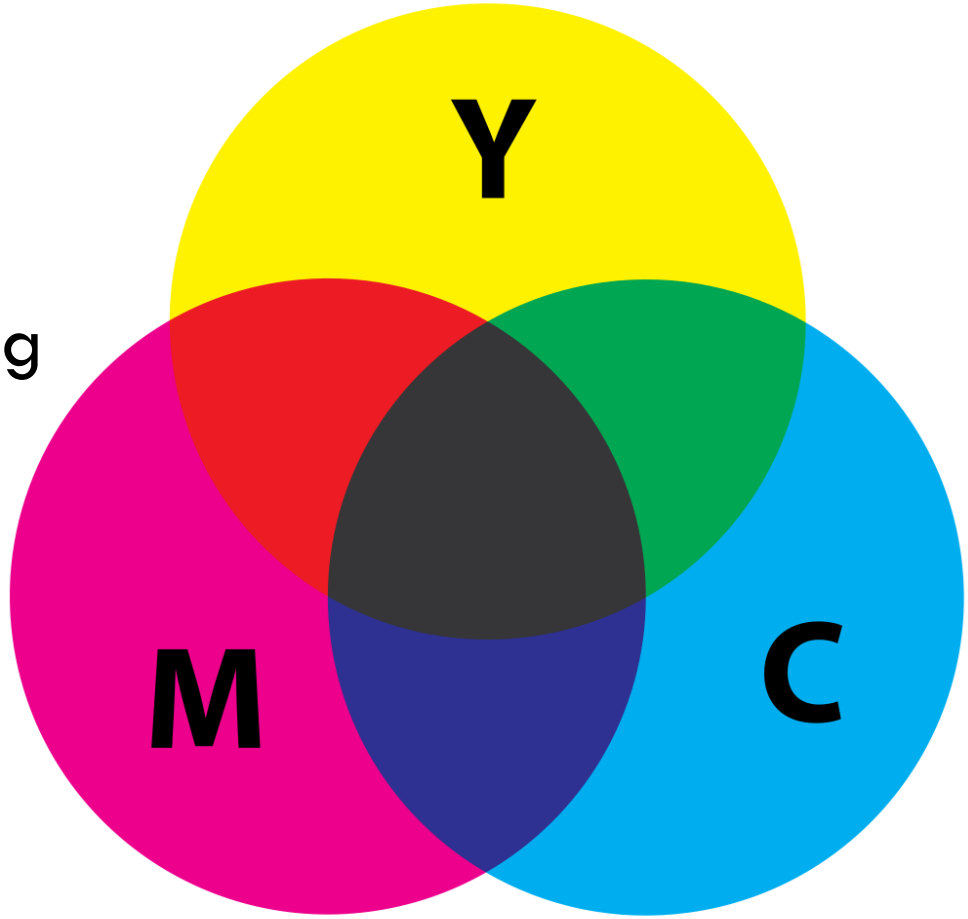
RGB

- Red
- Green
- Blue
- Additive color mixing



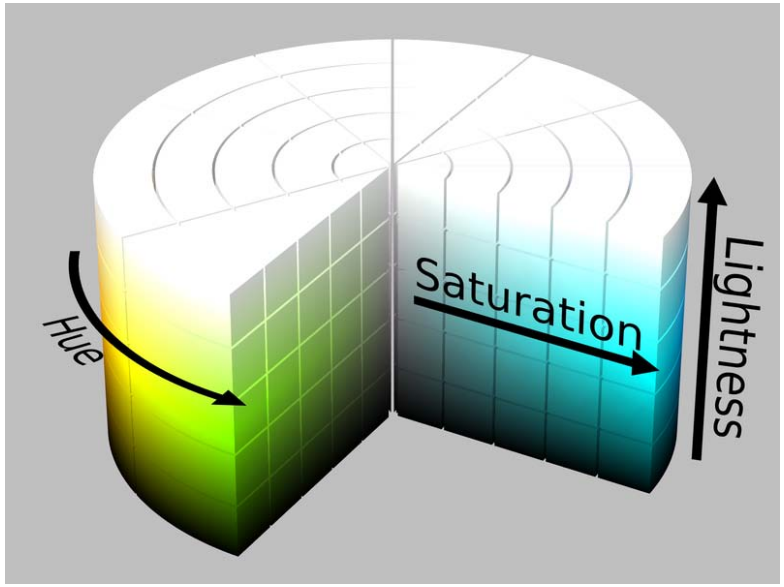
CMYK

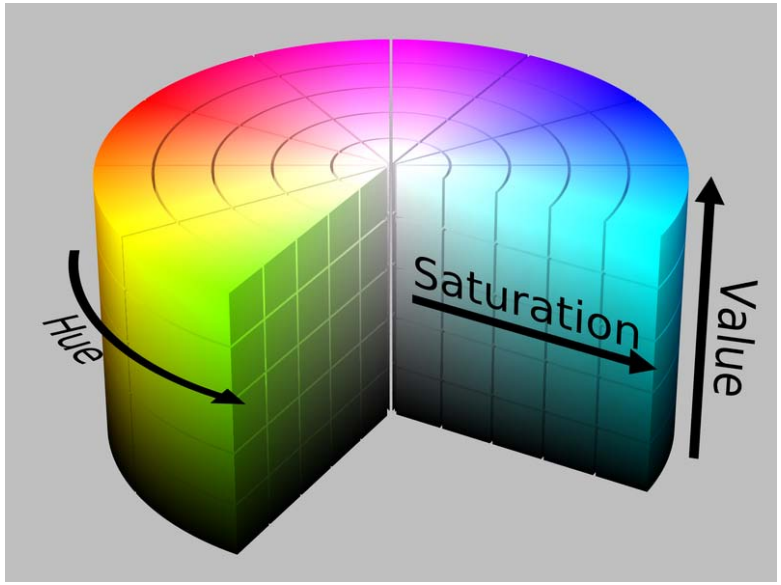
- Cyan
- Magenta
- Yellow
- Black
- Subtractive color mixing
- Used in printing



HSL and HSV

- Hue
- Saturation
- Lightness, Value



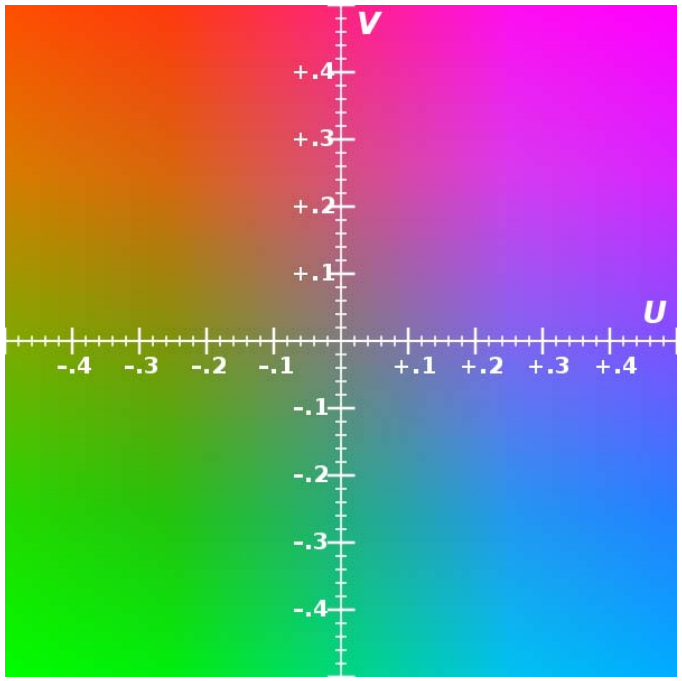


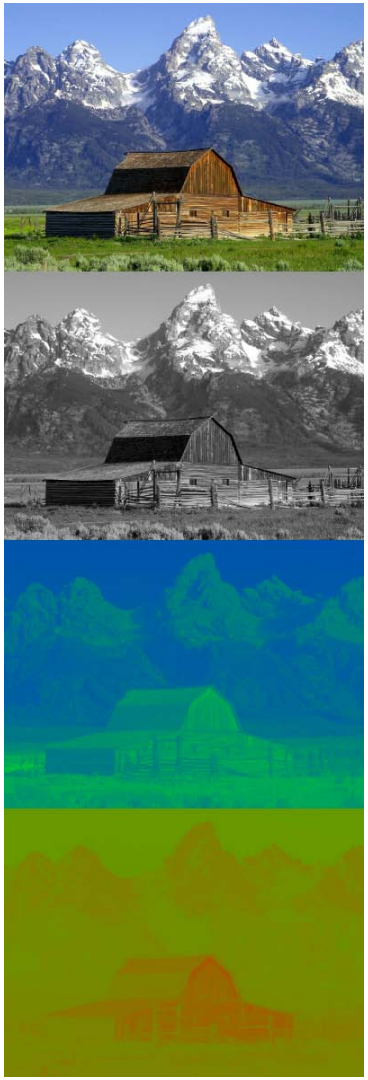
HSL and HSV - motivation

- User friendly

YUV

- Y – luma
- UV – chrominance
- TV (PAL)





Other Color Spaces

- XYZ
  - Based on human color perception
- YiQ
  - Rotated YUV (NTSC)
- YDbDr
  - Rotated YUV (SECAM)
- YPbPr, YCbCr
  - Scaled YUV, mostly digital
- LAB
  - Device independent model

Image Blending

Image Blending

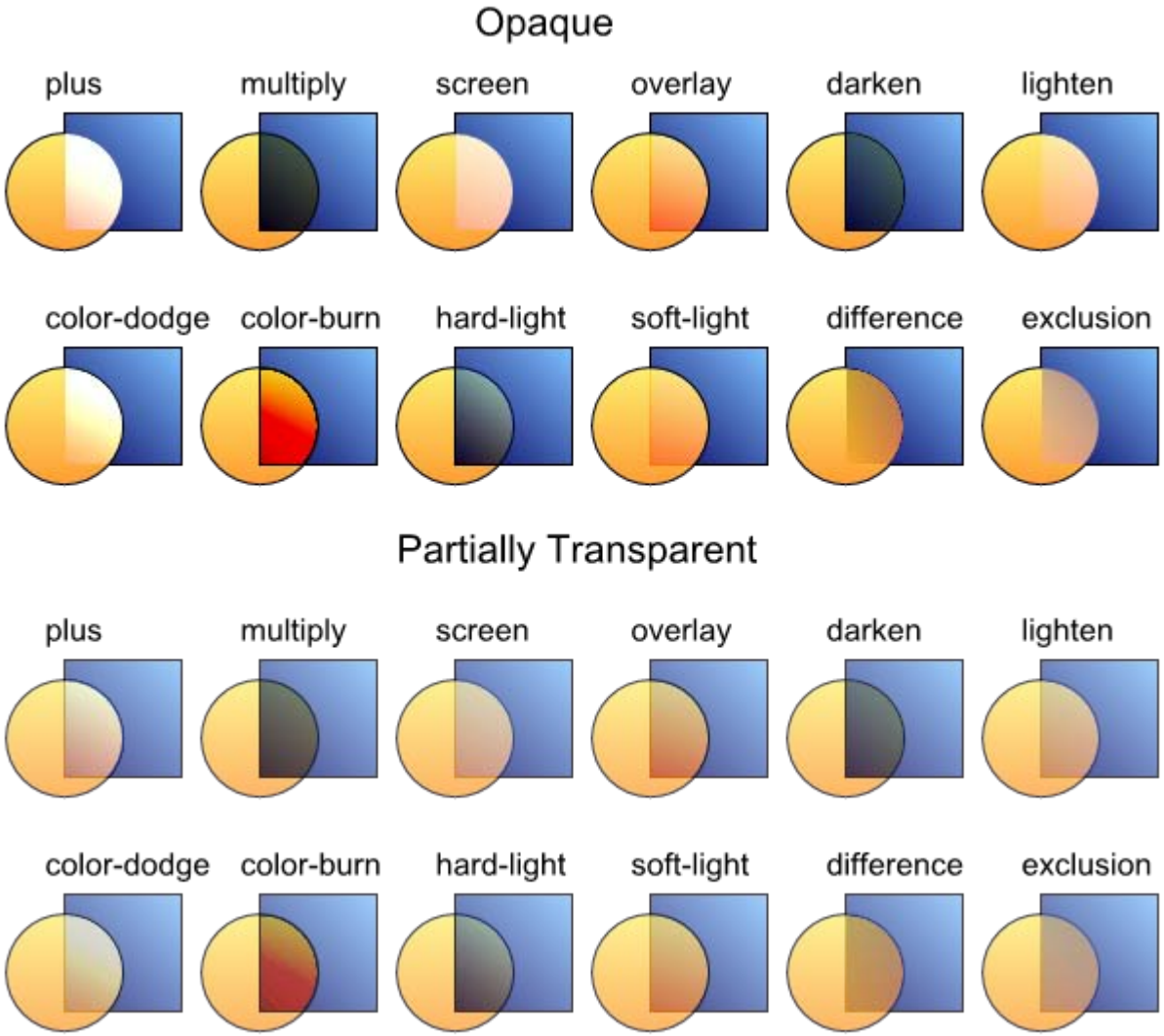


Image Blending

- Sc - The source element color value.
  - Sca = Sc*Sa
- Sa - The source element alpha value.
- Dc - The canvas color value prior to compositing.
  - Dca = Dc*Da
- Da - The canvas alpha value prior to compositing.
- Dc' - The canvas color value post compositing.
  - Dca' = Dc'*Da'
- Da' - The canvas alpha value post compositing.

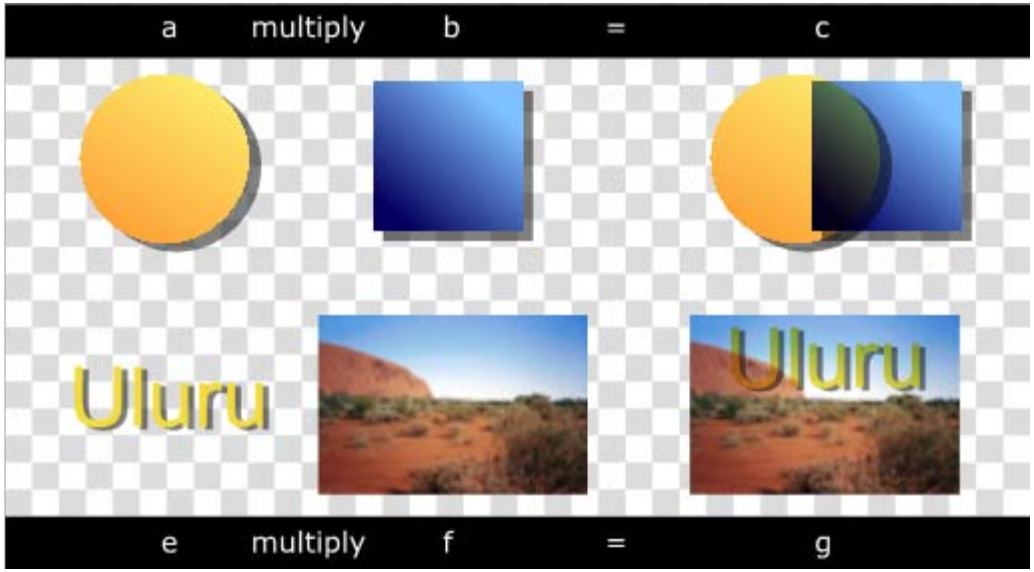
Image Blending

- c_s
  - Source color
  - Top layer
- c_b
  - Backdrop color
  - Bottom layer
- $C(c_b, c_s)$
  - Final color

Multiply

- At least as dark as either of the two components

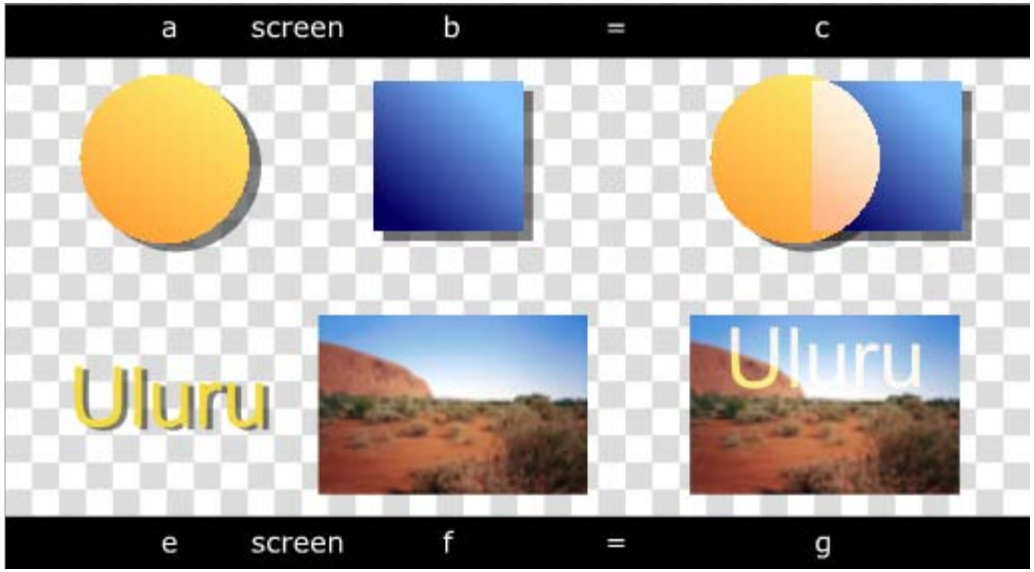
$$C(c_s, c_b) = c_s c_b$$



Screen

- At least as light as either of the two components

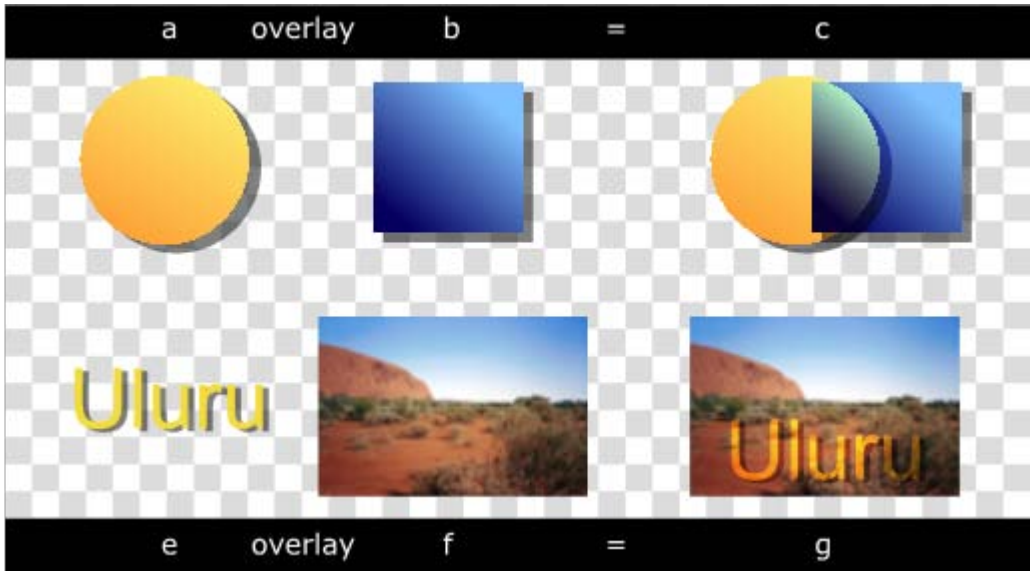
$$C(c_s, c_b) = 1 - [(1 - c_s)(1 - c_b)] = c_s + c_b - c_s c_b$$



Overlay

- Top layer overlays the bottom while preserving its highlights and shadows

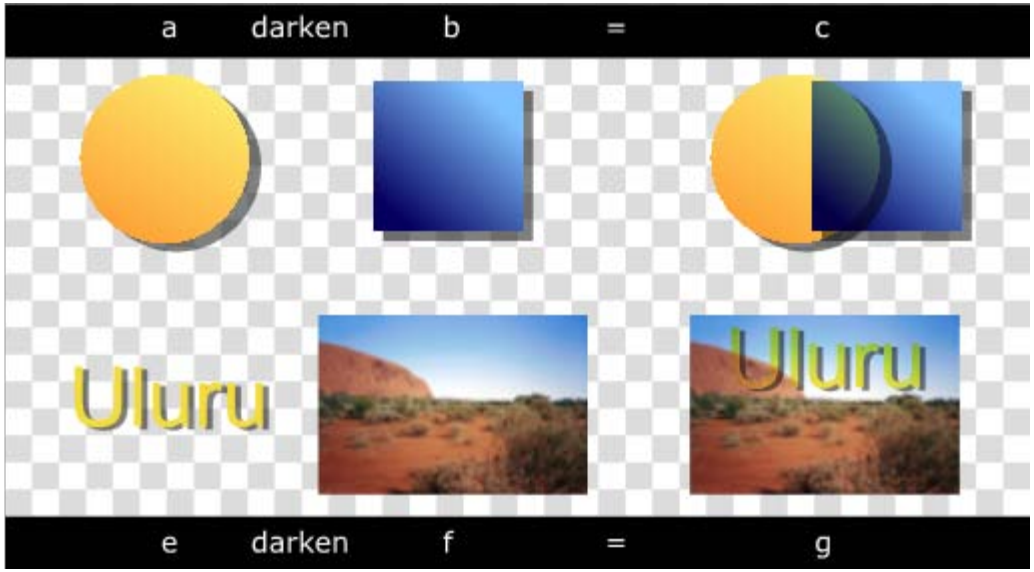
$$C(c_s, c_b) = \begin{cases} Multiply(c_s, 2c_b) & \text{if } c_b \le 0.5 \\ Screen(c_s, 2c_b - 1) & \text{if } c_b > 0.5 \end{cases}$$



Darken

- Replace color if the top layer is darker

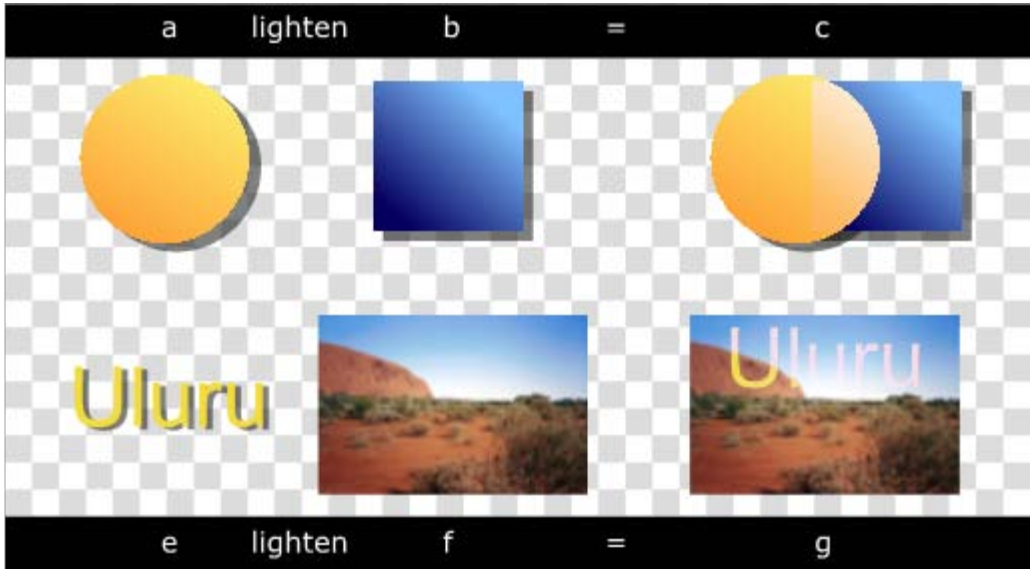
$$C(c_s, c_b) = \min(c_s, c_b)$$



Lighten

- Replace if the top layer is lighter

$$C(c_s, c_b) = \max(c_s, c_b)$$



Color Dodge

- Brightens the bottom layer color to reflect the top layer color

$$C(c_s, c_b) = \begin{cases} min(1, c_b / (1 - c_s)) & \text{if } c_s < 1 \\ 1 & \text{if } c_s = 1 \end{cases}$$

Color Burn

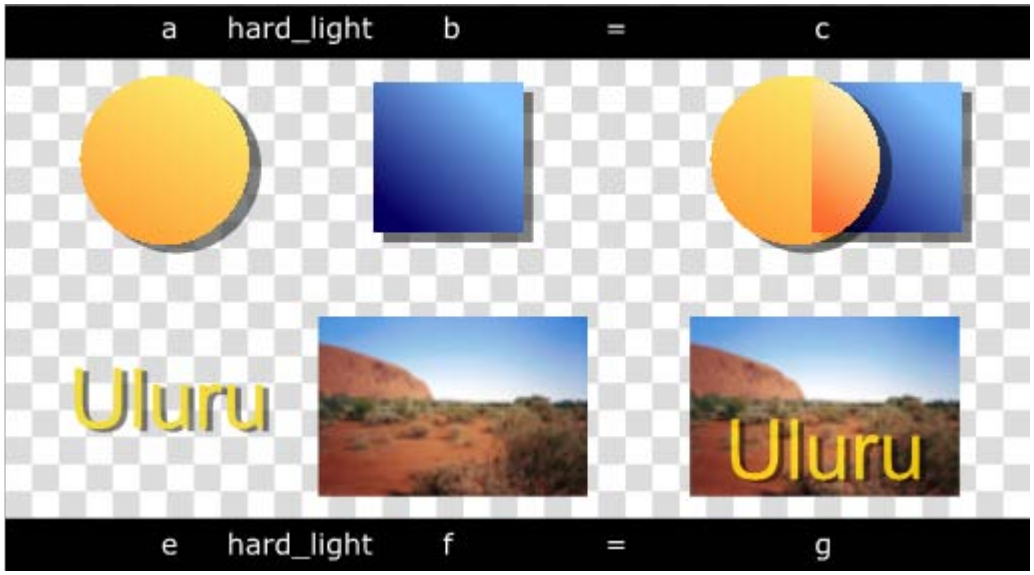
- Darkens the bottom layer color to reflect the top layer color

$$C(c_s, c_b) = \begin{cases} 1 - \min(1, (1 - c_b)/c_s) & \text{if } c_s > 1 \\ 1 & \text{if } c_s = 0 \end{cases}$$

Hard Light

- Similar to Overlay
- Swap layers

$$C(c_s, c_b) = \begin{cases} Multiply(2c_s, c_b) & \text{if } c_s \le 0.5 \\ Screen(2c_s - 1, c_b) & \text{if } c_s > 0.5 \end{cases}$$

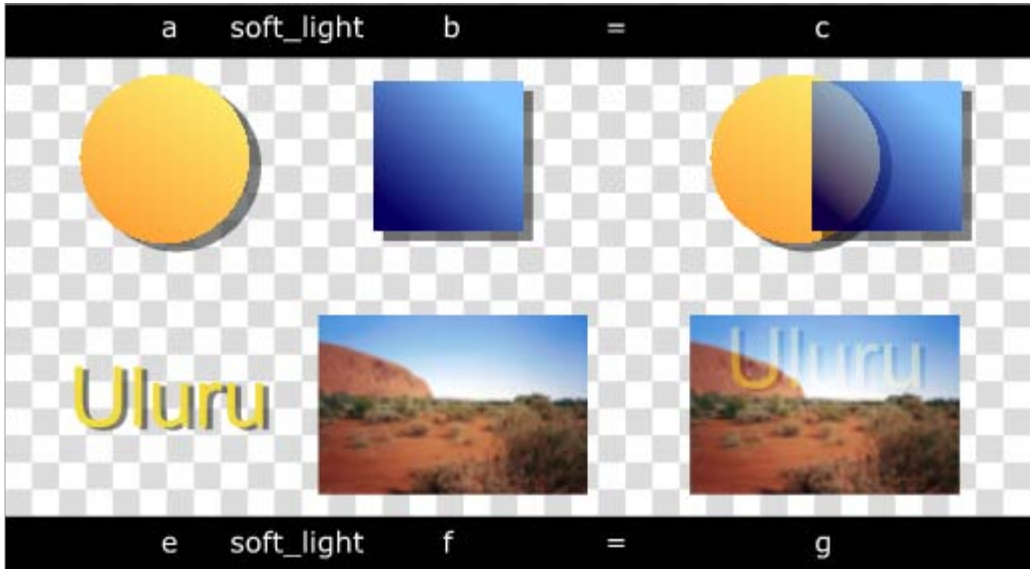


Soft Light

- Softer version of overlay

$$C(c_s, c_b) = \begin{cases} c_b - (1 - 2c_s)c_b(1 - c_b) & \text{if } c_s \le 0.5 \\ c_b + (2c_s - 1)(D(c_b) - c_b) & \text{if } c_s > 0.5 \end{cases}$$

$$\text{where } D(x) = \begin{cases} 16x^3 - 12x^2 + 4x & \text{if } x \le 0.25 \\ \sqrt{x} & \text{if } x > 0.25 \end{cases}$$



Soft and Hard Light – Comparison

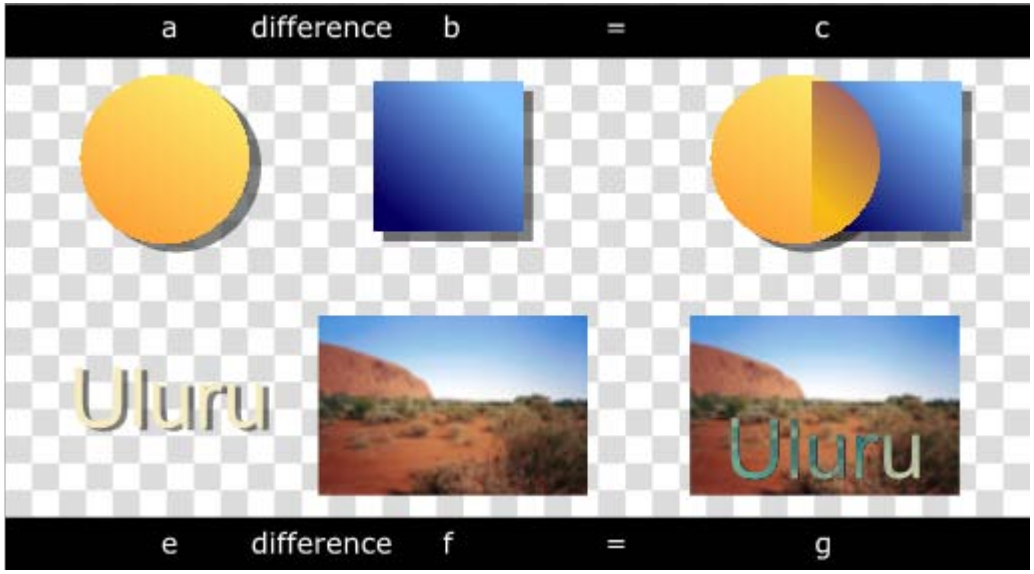
Hard Lite

Soft Light

Difference

- Subtracts the darker of the two constituent colors from the lighter color

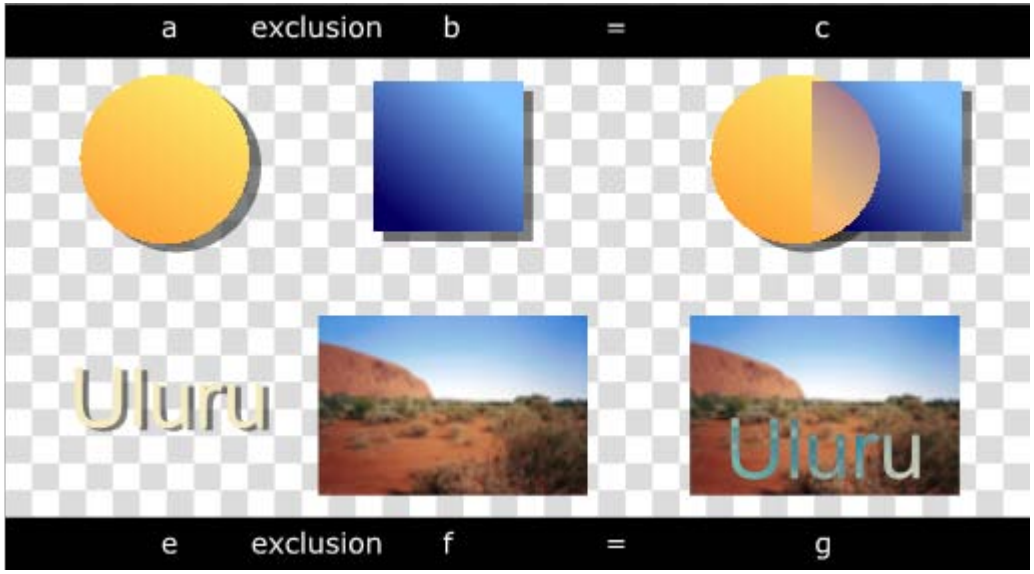
$$C(c_s, c_b) = |c_s - c_b|$$



Exclusion

- Produces an effect similar to that of the Difference mode but lower in contrast

$$C(c_s, c_b) = c_b + c_s - 2c_b c_s$$



Questions ???