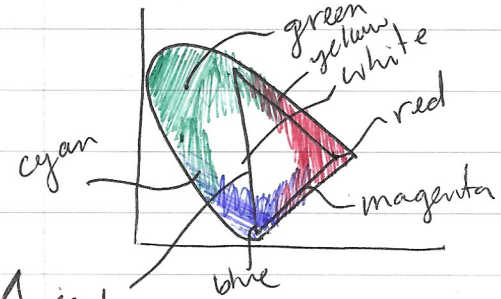
Bradley Cage

CS 184

Color

- Mix of several frequencies
- Linear phenomenon
- You do not "see" the light spectrum
- Brain adapts
- Eyes
  - Mesopic
    - Scotopic
      - Rods
        - No color
        - Sensitive
        - All over Retina
    - Photopic
      - Cones
        - Long, medium, short
        - less sensitive
        - Each cone → specific dist.
        - Concentrated in fovea.
- Cannot display "negative" light.
- Displayed $\in [0,1]$
-



Δ is gamut.

RGB	Colour
1,0,0	Red
0,1,0	green
0,0,1	blue
1,1,0	yellow
1,0,1	magenta
0,1,1	cyan

- w/ 3 primaries

$$\phi = W - (\alpha p_1 + \beta p_2 + \gamma p_3)$$

(W: white)

- Gamma

$$I = \alpha^{\gamma} \qquad \gamma_A \in (1.8, 2.2)$$

- Dynamic Range
  - "blackest black"
  - "Whitest white"
- Reflection
  - → Some light bounces off
- Transmission
  - → Some light passes through
- Scattering (due to particles)
- Black body radiation
  - → makes hot objects give off light

Vectors

- $A+B = B+A$
- $A \cdot B = B \cdot A$
- $A \times B = -B \times A$
- $(A-B)\cdot C = A\cdot C + B\cdot C$
- $(A-B)\times C = A\times C + B\times C$
- $A\cdot(B\times C) = B\cdot(C\times A) = C\cdot(A\times B)$ (scalar triple products)
- $A\times(B\times C) = (A\cdot C)B - (A\cdot B)C$ (vector triple products)
- $(A\times B)\times C = (A\cdot C)B - (B\cdot C)A$ (vector triple products)
- $(A\times B)\cdot(C\times D) = (A\cdot C)(B\cdot D) - (B\cdot C)(A\cdot D)$
- $(A\cdot(B\times C))D = (A\cdot D)(B\times C) + (B\cdot D)(C\times A) + (C\cdot D)(A\times B)$
- $(A\times B)\times(C\times D) = (A\cdot(B\times D))C - (A\cdot(B\times C))D$

$A+B = B+A$

- if scalar triple prod 2 are same = 0

Shading

- Bi-Directional Reflectance Distribution Function (BRDF)
  - Surface material, light direction, view direction surface orientation.

BRDF = Ambient + Specular + Diffuse.

- Diffuse - ~~equal~~ scattering in all directions regardless of orientation.

$$\max(k_d \cdot I \cdot (\hat{l}\cdot\hat{n}, 0))$$

($\hat{l}$: light dir, $\hat{n}$: surface normal)

- Specular - mirror-like reflection in a small direction

$\hat{r}$ = reflected vector.

$$\underset{\sim}{r} = -2(\underset{\sim}{d}\cdot\hat{n})\hat{n} + \underset{\sim}{d} \quad \text{where } \underset{\sim}{d} = \hat{l}$$

$$\max(k_s \cdot I \cdot (\hat{r}\cdot\hat{v}, 0)^p)$$

- Ambient - cheap hack, all other light.

$$R = I[k_a + k_d \max(\hat{l}\cdot\hat{n}, 0) + k_s \max(\hat{r}\cdot\hat{v}, 0)^p]$$

- Metal → reflects same color specular
- Plastic → reflects white color specular.
- Lights
  - Directional
    - Far away point light.
    - Hits every point the same.
  - Point
    - Closer
    - Changes point to point.
- Gouraud
  - Interpolate from vertex color
- Phong - Interpolate from normals

2D Transformation

- Rotation

$$p' = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} p$$

  - Rotates around (0,0)
- Scale

$$p' = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} p$$

- Shear

$$p' = \begin{bmatrix} 1 & H_{yx} \\ H_{xy} & 1 \end{bmatrix} p$$

(H_{yx}: moves in x; H_{xy}: moves in y)

- Singular Value Decomp.

$$A = QSR^T$$

(Q, R: orthonormal; S: diagonal)

also

$$A = PRSR^T$$

($P = QR^T$ orthonormal)

make $\det(P, R) = 1$

Any matrix A is now: Rotate · Rotate · Scale · Rotate

- Homogeneous coordinates, add a w to each vector $\langle x, y, z, w\rangle$
  - For directions $w = 0$.
  - Divide by w
  - Translation

$$\hat{p}' = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} p_x \\ p_y \\ 1 \end{bmatrix}$$

- All other matrices

$$\hat{A} = \begin{bmatrix} A & 0 \\ 0\ 0 & 1 \end{bmatrix}$$

- Inverses
  - Translation → negate t_x, t_y
  - Rotation → transpose
  - Scale → invert diagonal

others → Invert matrix
Invert SVD matrices.