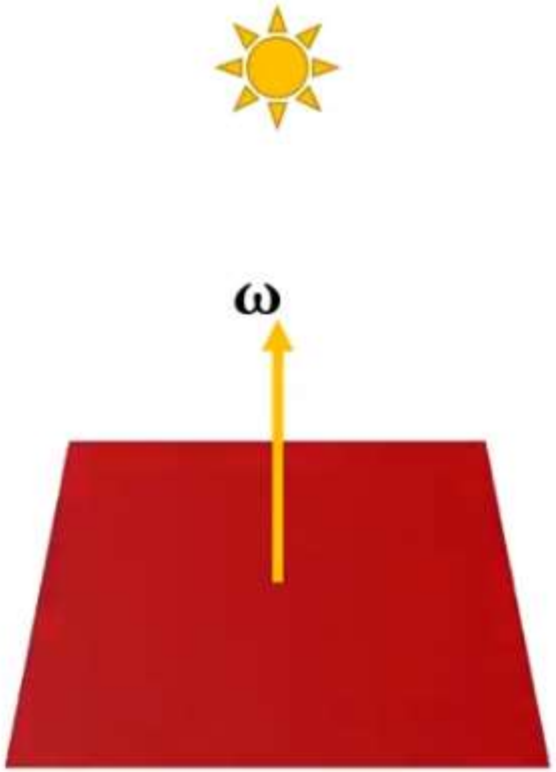
Lighting and shading

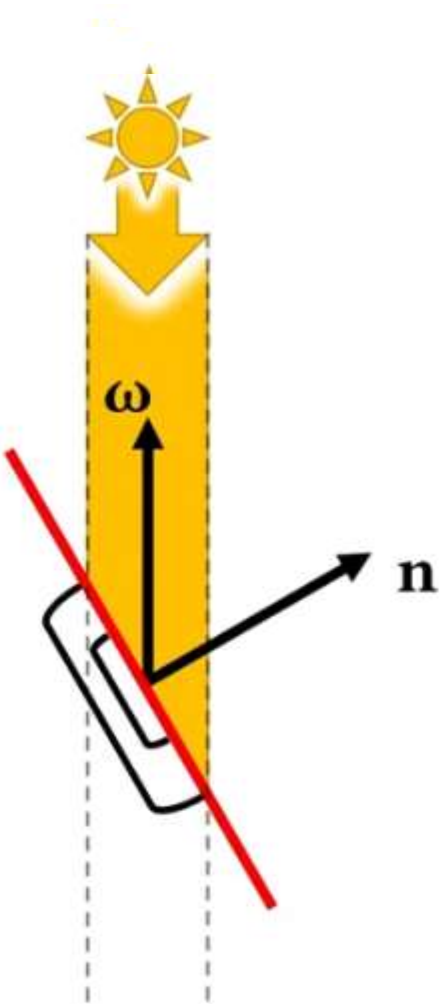
Raghavendra G S

Shading

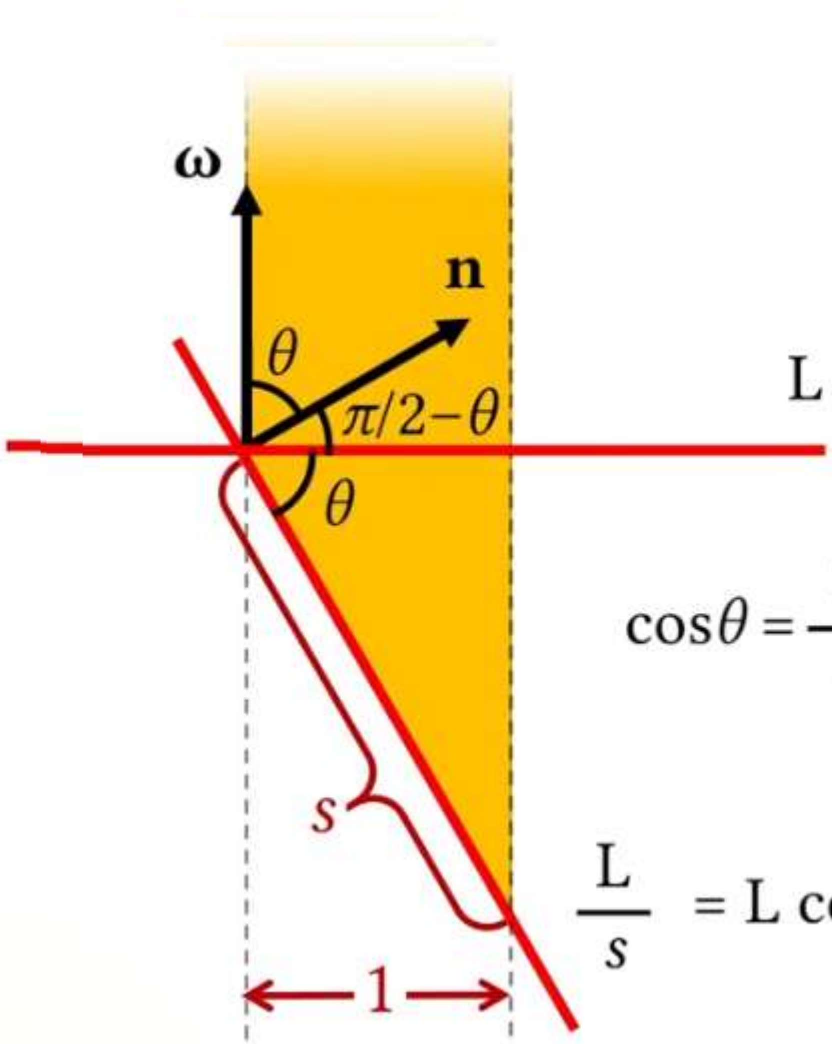
Shading



Shading



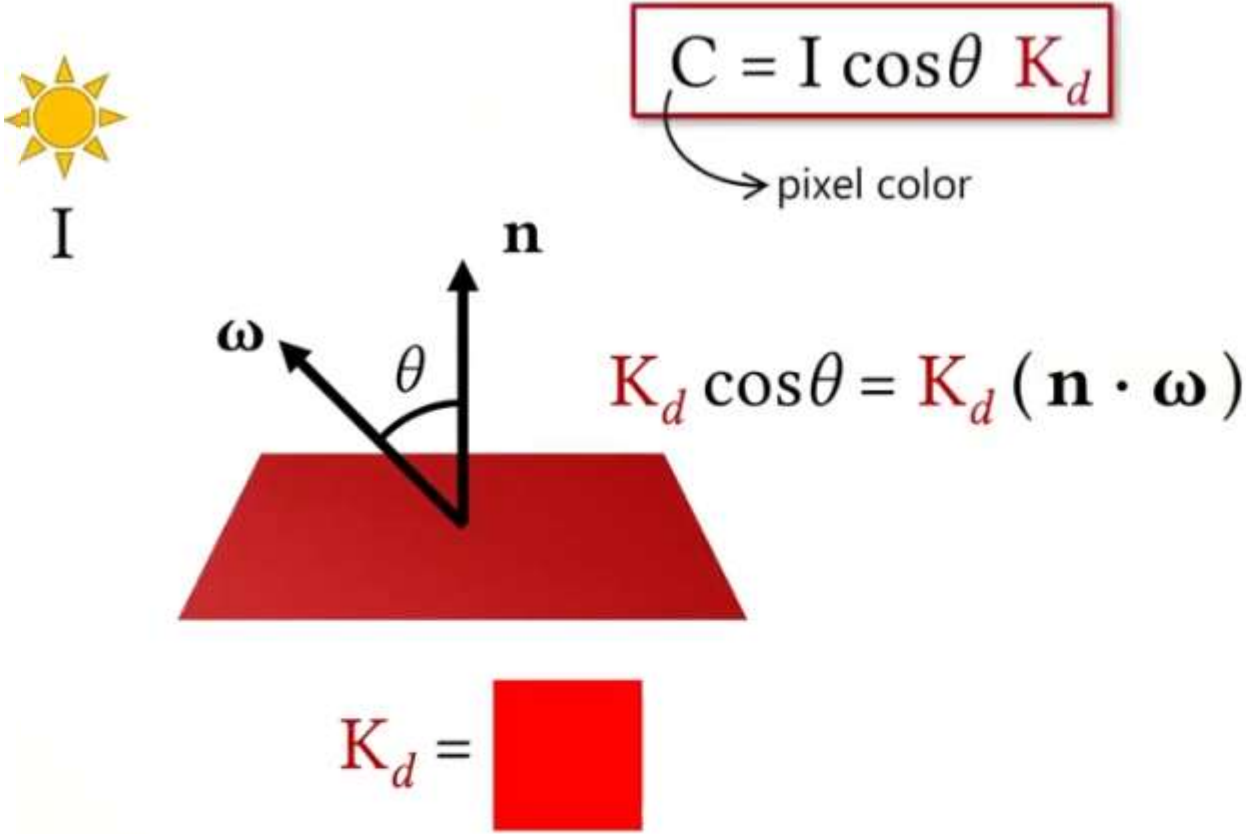
Shading



$$\cos\theta = \frac{1}{s}$$

$$\frac{L}{s} = L\cos\theta$$

Shading

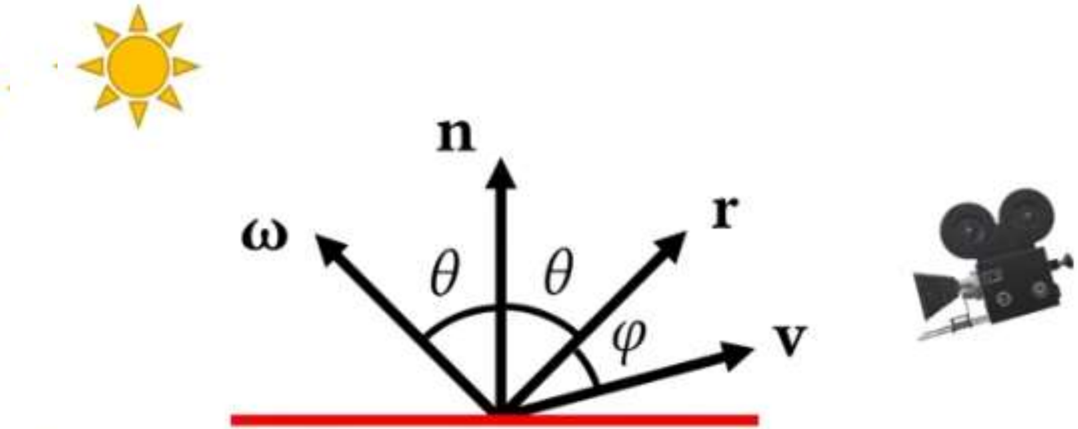

$C = I\cos\theta\ K_d$
pixel color
I
$\mathbf{n}$
$\boldsymbol{\omega}$
θ
$K_d \cos\theta = K_d(\mathbf{n}\cdot\boldsymbol{\omega})$
$K_d =$

Diffuse

Specular

Specular

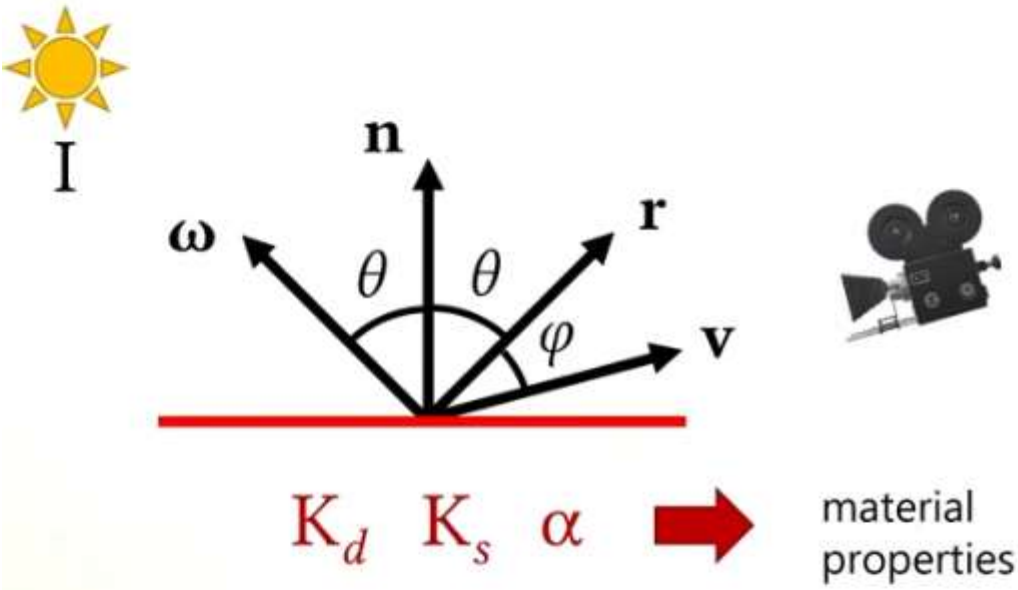
$$K_s(\cos\varphi)^{\alpha} = K_s(\mathbf{v} \cdot \mathbf{r})^{\alpha}$$



$K_s \quad \alpha$ → material properties

Combine

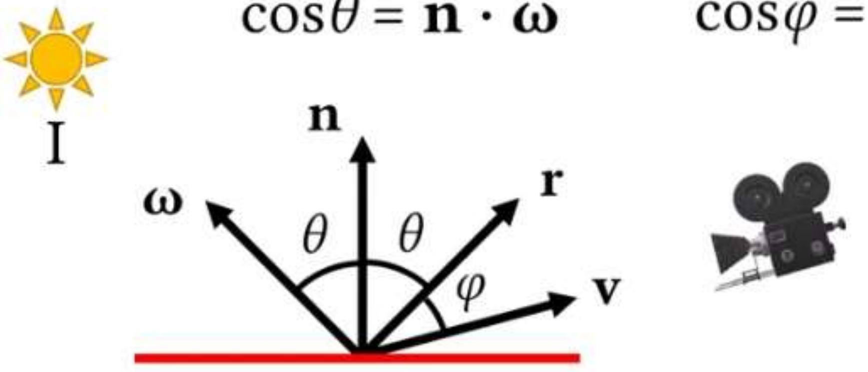
$$C = I\cos\theta\left(K_d + K_s\frac{(\cos\varphi)^{\alpha}}{\cos\theta}\right)$$



Combine

$$C = I \max(0, \cos\theta) \left(K_d + K_s \frac{(\max(0, \cos\varphi))^{\alpha}}{\cos\theta} \right)$$

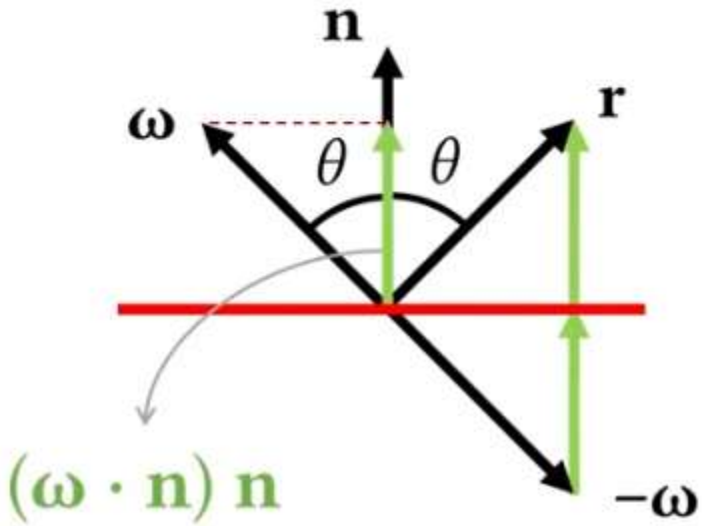
$$\cos\theta = \mathbf{n} \cdot \boldsymbol{\omega} \qquad \cos\varphi = \mathbf{r} \cdot \mathbf{v}$$



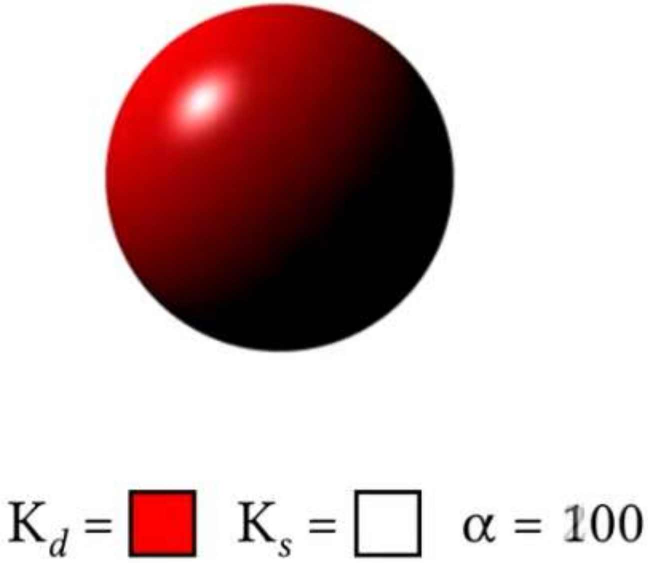
K_d K_s α → material properties

Calculate

$$\mathbf{r} = 2(\boldsymbol{\omega} \cdot \mathbf{n})\,\mathbf{n} - \boldsymbol{\omega}$$



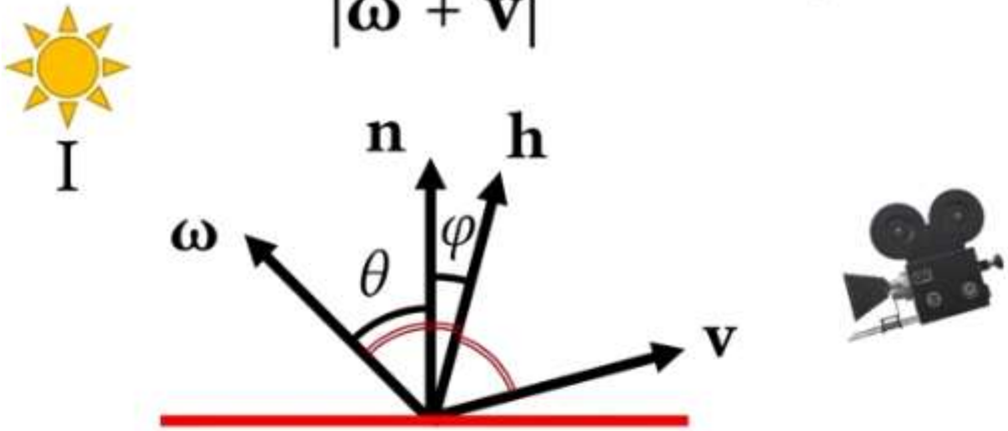
Phong Model



Blinn

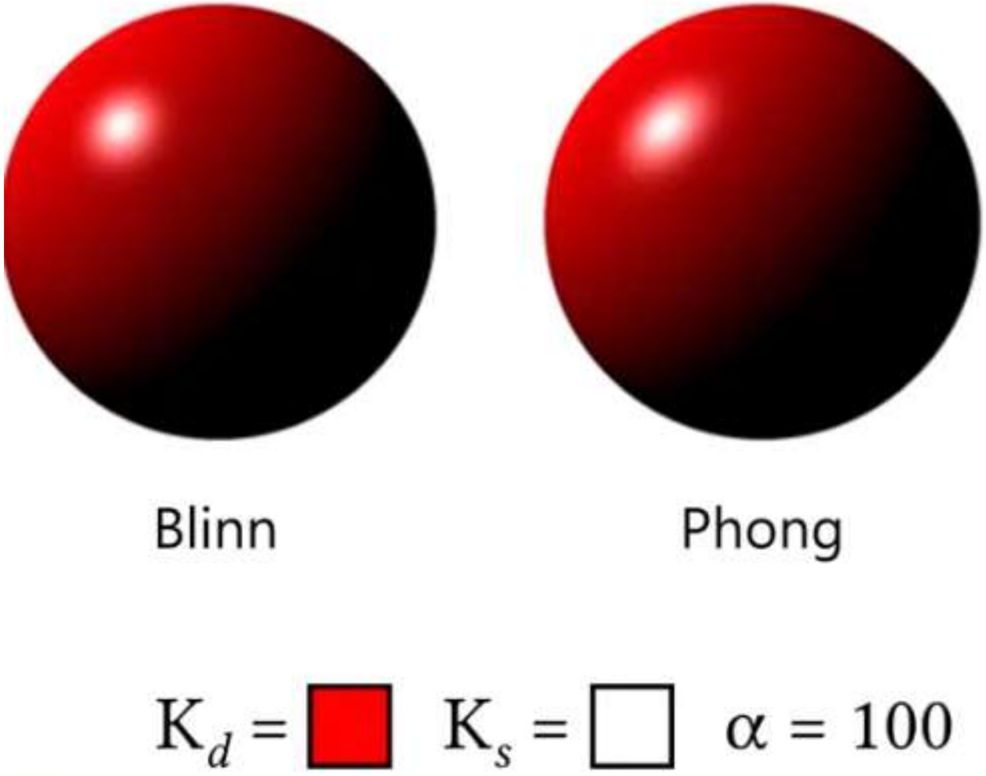
$$C = I\left(\cos\theta\, K_d + K_s(\cos\varphi)^{\alpha}\right)$$

$$\mathbf{h} = \frac{\boldsymbol{\omega} + \mathbf{v}}{|\boldsymbol{\omega} + \mathbf{v}|} \qquad \cos\varphi = \mathbf{n}\cdot\mathbf{h}$$



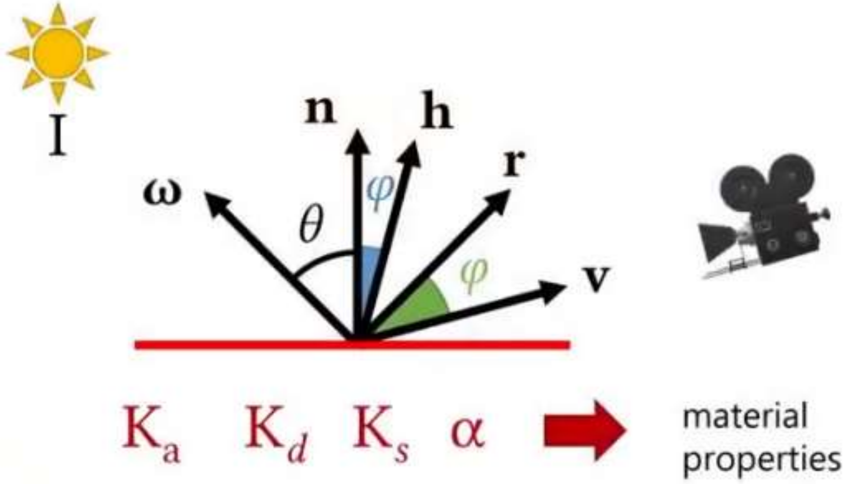
K_d K_s α → material properties

Difference

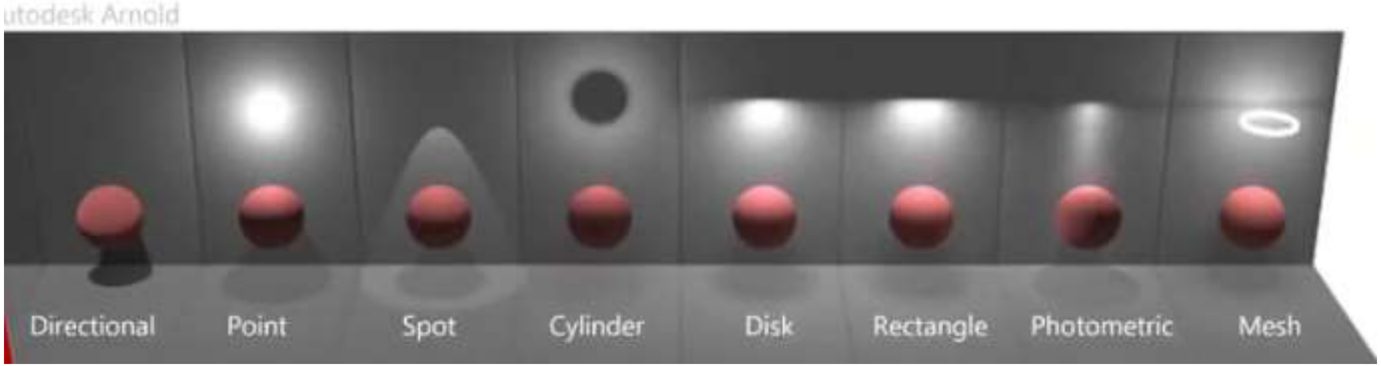


Ambient light

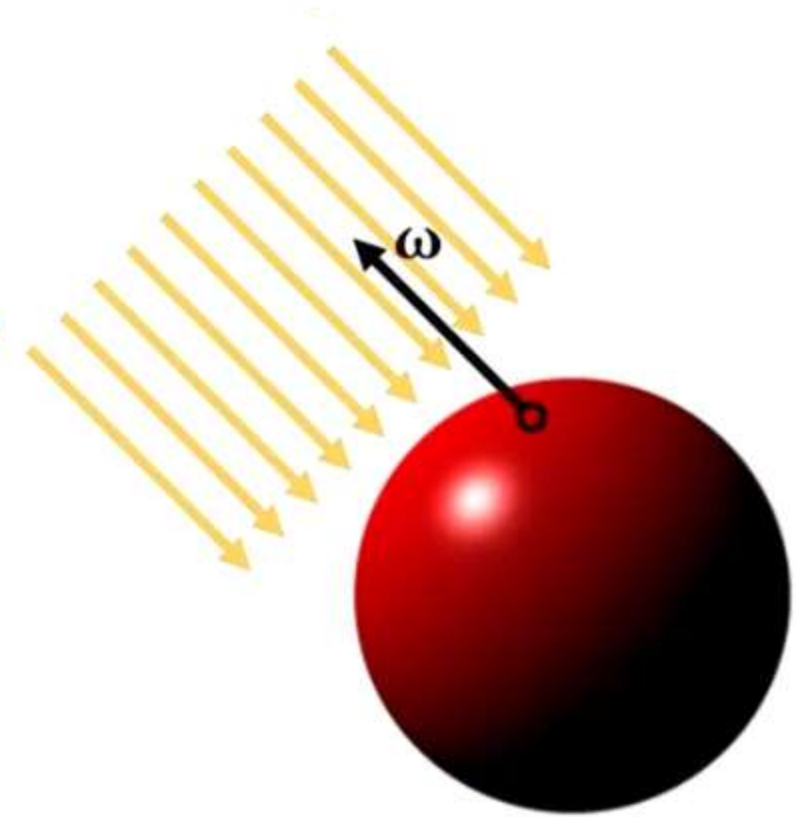
$$C = I\left(\cos\theta\, K_d + K_s(\cos\varphi)^\alpha\right) + I_a\, K_a$$



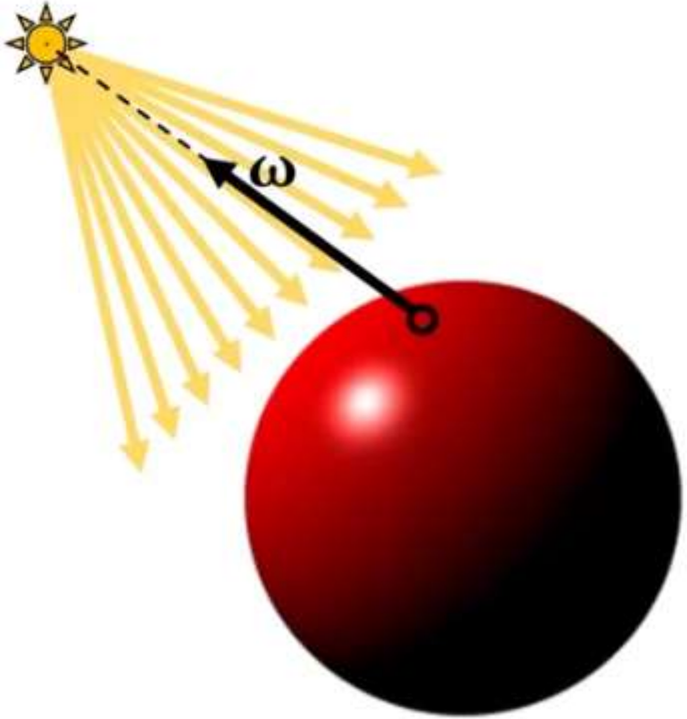
Types


utodesk Arnold
Directional
Point
Spot
Cylinder
Disk
Rectangle
Photometric
Mesh

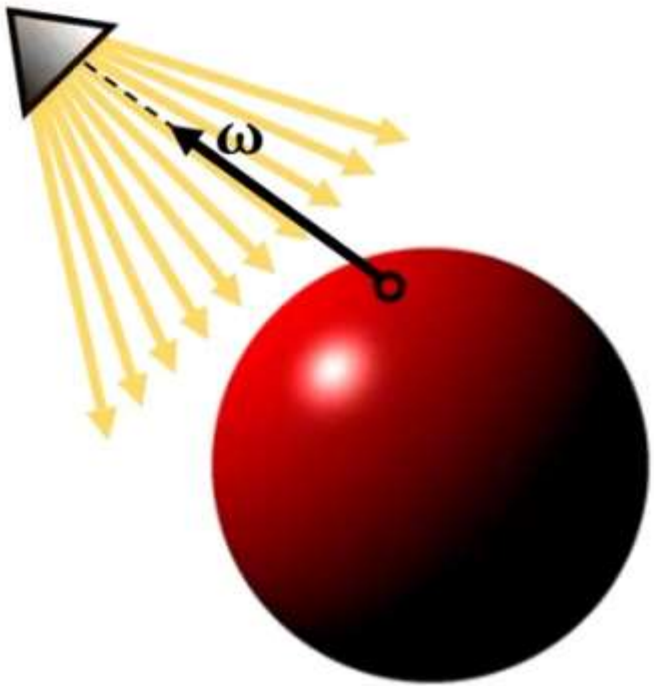
Directional



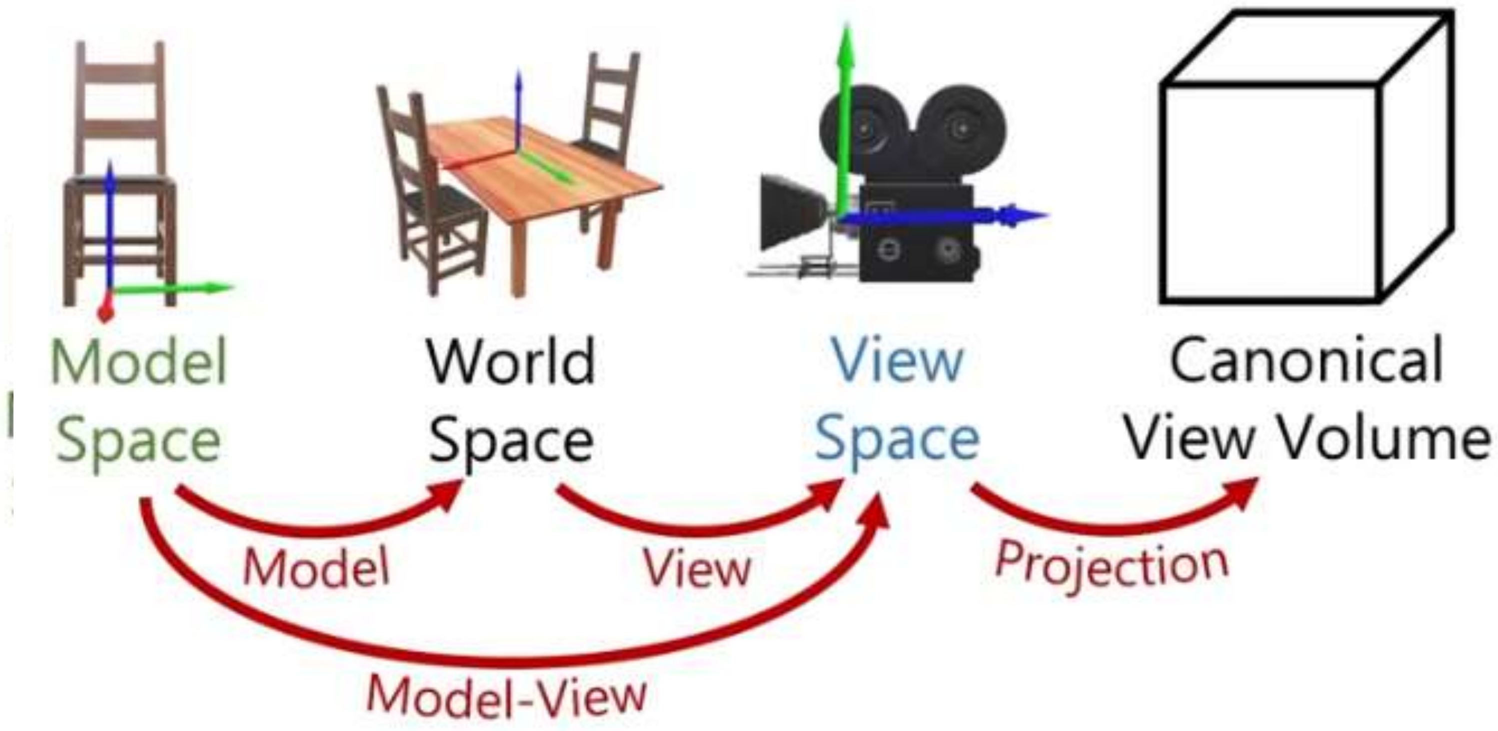
Point



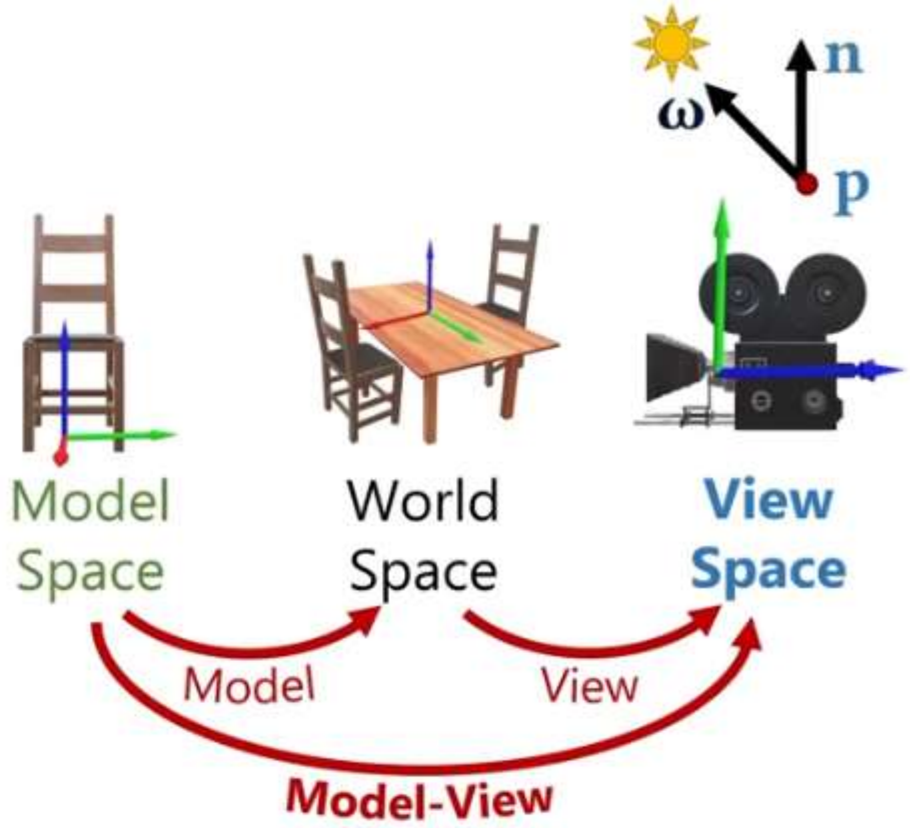
Spotlight



Transformations



Transformations



Transformations

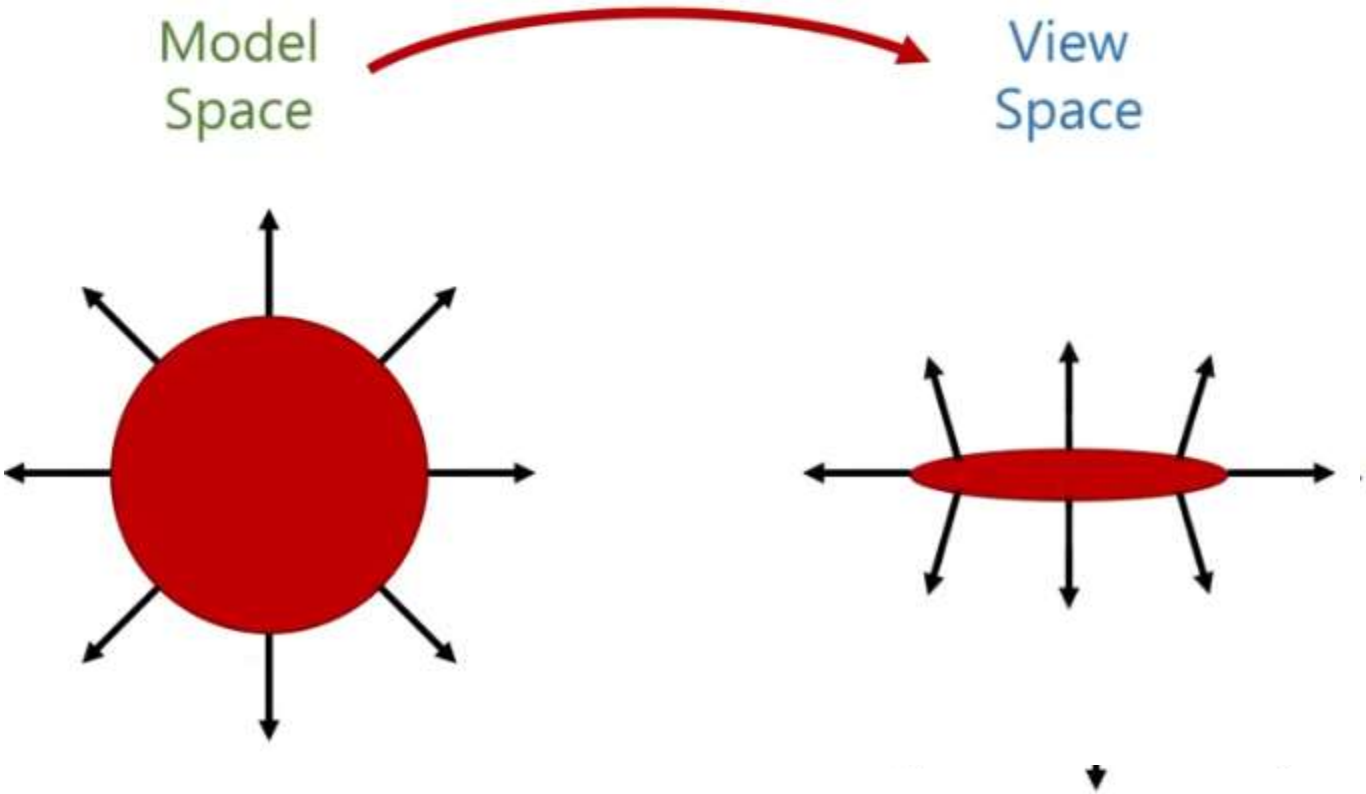
View Space ← Model Space

$$\mathbf{p}' = \mathbf{M}\,\mathbf{p}$$ ← positions

$$\mathbf{n}' = \ ?\ \mathbf{n}$$ ← normals

$\mathbf{M}$ is the model-view transformation matrix

Transformations



Handling Normals

View Space

Model Space

$$\mathbf{p'} = \mathbf{M}\begin{bmatrix} p_x \\ p_y \\ p_z \\ 1 \end{bmatrix}$$

positions

$$\mathbf{n'} = \mathbf{M}_{3x3}\begin{bmatrix} n_x \\ n_y \\ n_z \\ 0 \end{bmatrix}$$

normals

Handling Normals

$$\mathbf{M}_{3x3} = \mathbf{R}_2\,\mathbf{S}\,\mathbf{R}_1$$

$$\mathbf{M}_{normal} = \mathbf{R}_2\,\mathbf{S}^{-1}\,\mathbf{R}_1$$

$$\mathbf{M}_{3x3}^{-1} = \mathbf{R}_1^{-1}\,\mathbf{S}^{-1}\,\mathbf{R}_2^{-1}$$

$$(\mathbf{M}_{3x3}^{-1})^{T} = \mathbf{R}_2\,(\mathbf{R}_1^{T}\,\mathbf{S}^{-1})^{T}$$

Handling Normals

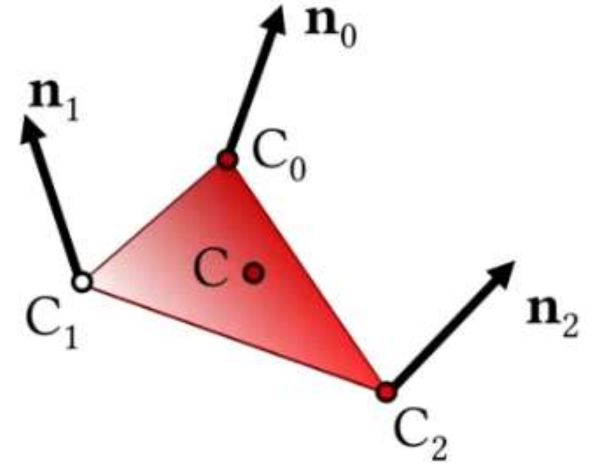
View Space $\leftarrow$ Model Space

$$\mathbf{p}' = \mathbf{M}\,\mathbf{p}$$ ⬅ positions

$$\mathbf{n}' = \left(\mathbf{M}_{3x3}^{-1}\right)^{T}\mathbf{n}$$ ⬅ normals

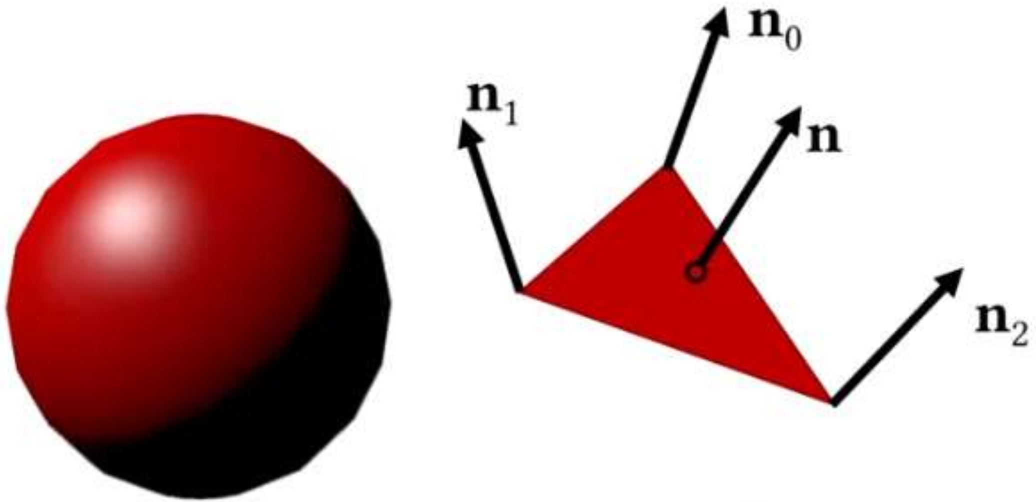
$\mathbf{M}$ is the model-view transformation matrix

Gouraud Shading



$$C = \alpha\, C_0 + \beta\, C_1 + \gamma\, C_2$$

Phong Shading



$$\mathbf{n} = \frac{\alpha\,\mathbf{n}_0 + \beta\,\mathbf{n}_1 + \gamma\,\mathbf{n}_2}{|\alpha\,\mathbf{n}_0 + \beta\,\mathbf{n}_1 + \gamma\,\mathbf{n}_2|}$$

Flat vs Gouraud vs Phong