Local Illumination

CMSC 435/634

Illumination

- Effect of light on objects
- Mostly look just at intensity
  - Apply to each color channel independently
- Good for most objects
  - Not fluorescent
  - Not phosphorescent

Local Illumination

- Light sources shining directly on object

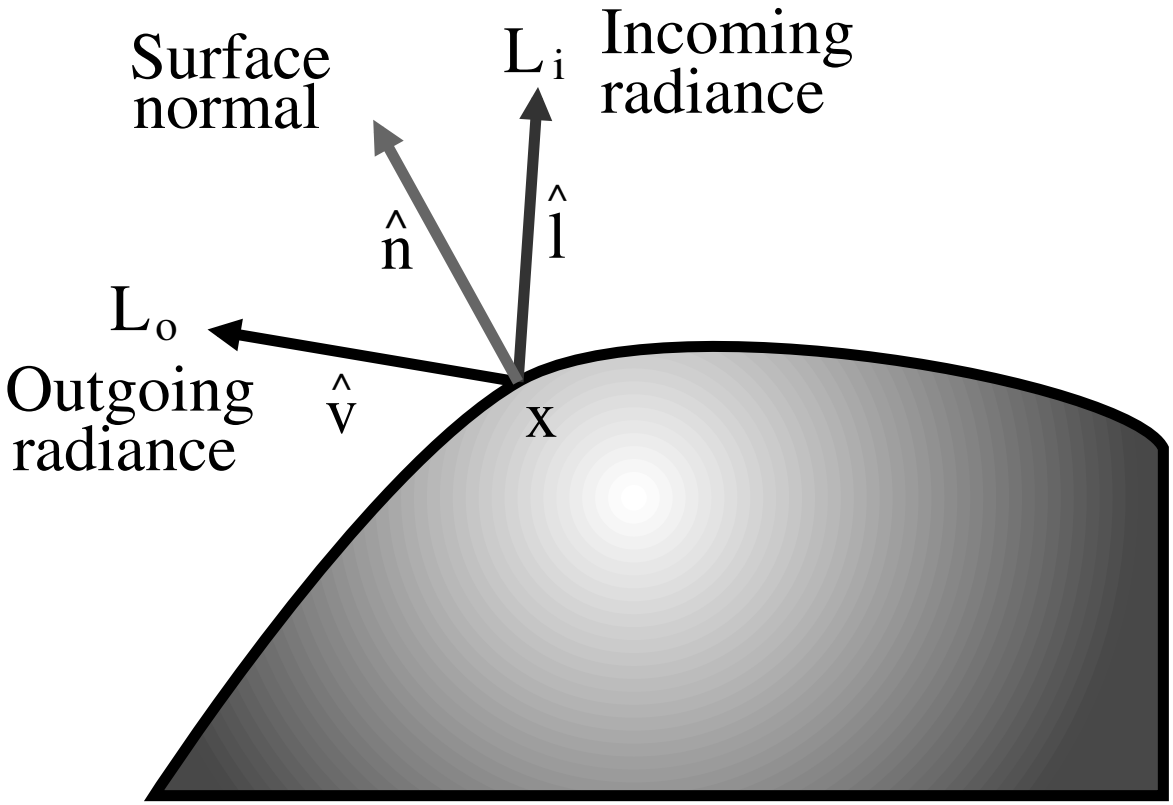
Global Illumination

- Lights from objects shining on other objects
- Ambient Illumination
  - Approximate global illumination as constant color
  - Typically ≈1% of direct illumination

BRDF

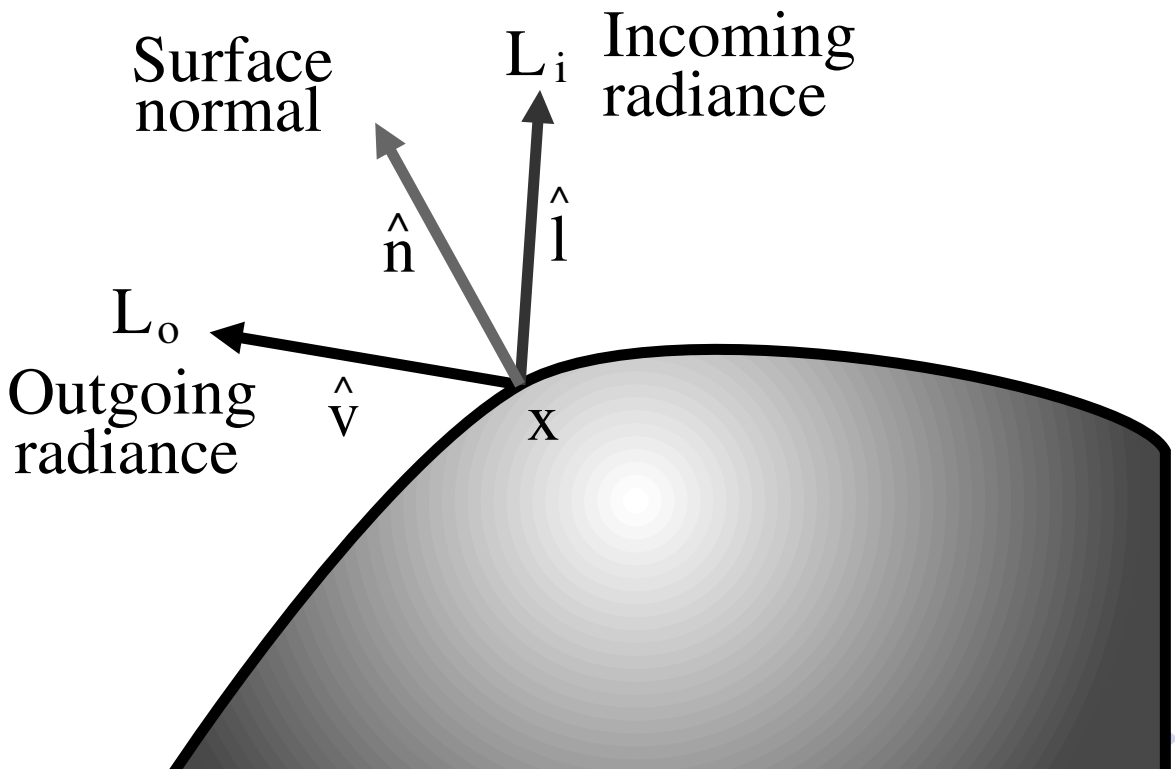
Bidirectional Reflectance Distribution Function

How much light reflects from L_i to L_o



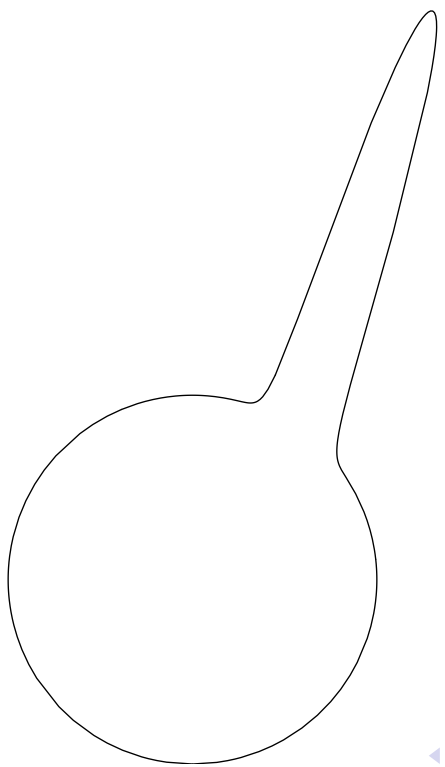
Physically Plausible BRDF

- Positive
- Reciprocity
  - Same light from L_i to L_o as from L_o to L_i
- Conservation of Energy
  - Don't reflect more energy than comes in



Plotting BRDFs

- Polar plot of reflectance strength
  - For **one** view direction, showing light directions
  - For **one** light direction, showing view directions
- Reciprocity – same if you swap view and light



Rendering Equation

Integral of all Incoming Light

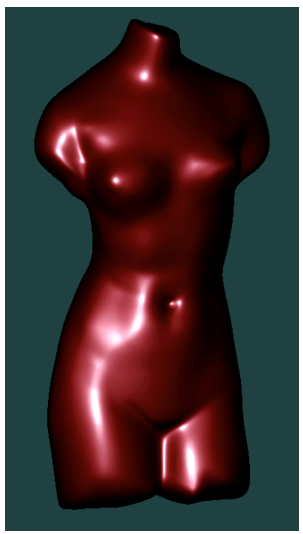
$$L_o(\vec{v}) = \int_{\Omega(\vec{n})} f_r(\vec{v} \leftarrow \vec{l})\, L_i(\vec{l})\, \vec{n} \bullet \vec{l}\, d\omega(\vec{l})$$

Parts of this equation:

$L_o(\vec{v})$	outgoing light in direction $\vec{v}$
$\Omega(\vec{n})$	hemisphere above $\vec{n}$
$f_r(\vec{v} \leftarrow \vec{l})$	BRDF from $\vec{l}$ to $\vec{v}$
$L_i(\vec{l})$	incoming light from direction $\vec{l}$
$\int_{\Omega(\vec{n})} ... \vec{n} \bullet \vec{l}\, d\omega(\vec{l})$	integration over hemisphere
$\vec{n} \bullet \vec{l}\, d\omega(\vec{l})$	projection of differential solid angle onto surface

Results

- Integrating full environment
- Light at one point, black elsewhere

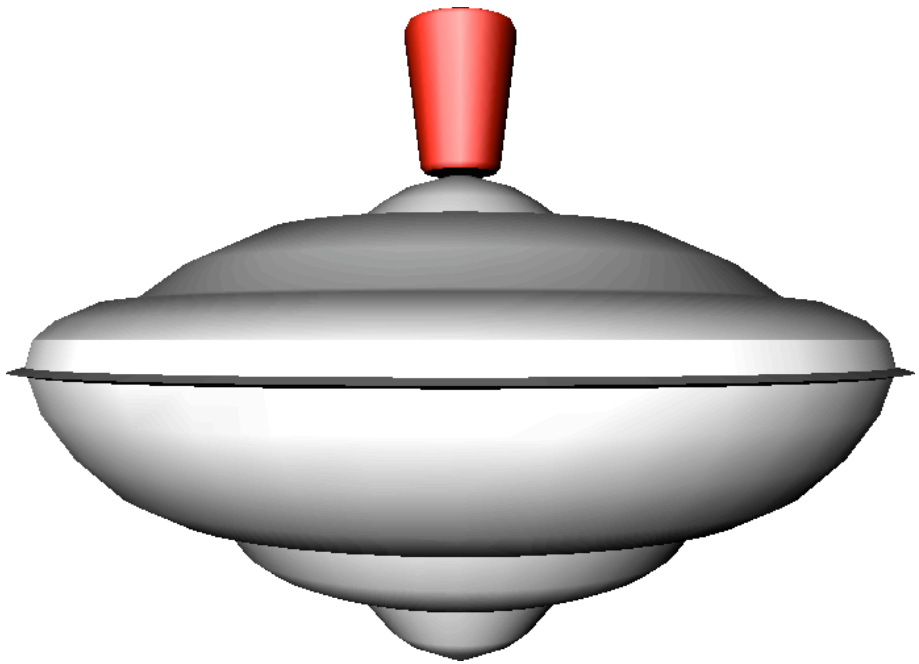



Important directions

$\hat{n}$	Surface normal
$\hat{v}$	Vector from surface toward viewer
$\hat{l}$	Vector from surface toward light
$\hat{r}_v = 2\hat{n}(\hat{n} \bullet \hat{v}) - \hat{v}$	Mirror reflection direction for view
$\hat{r}_l = 2\hat{n}(\hat{n} \bullet \hat{l}) - \hat{l}$	Mirror reflection direction for light
$\hat{h} = \frac{\hat{v}+\hat{l}}{\lvert\hat{v}+\hat{l}\rvert}$	Normal direction that would reflect $\hat{v}$ to $\hat{l}$

Diffuse

- Also called Lambertian or Matte
- Constant BRDF
- Total reflectance $\hat{n} \bullet \hat{l}$



Specular

- Phong
  - Strongest where $\hat{r}_l$ lines up with $\hat{v}$
  - Strongest where $\hat{r}_v$ lines up with $\hat{l}$
  - $(\hat{r}_l \bullet \hat{v})^e = (\hat{r}_v \bullet \hat{l})^e$
- Blinn-Phong
  - Alternate formulation, similar behavior
  - Strongest where $\hat{h}$ lines up with $\hat{n}$
  - $(\hat{n} \bullet \hat{h})^e$