Light Sources

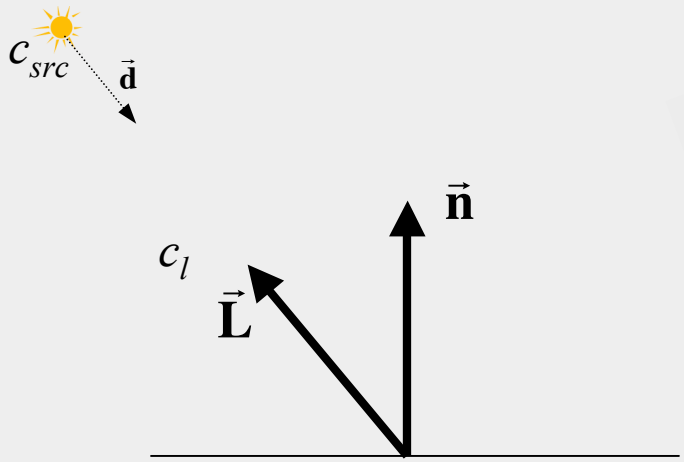
- In general, light sources can have complex properties
  - Geometric area over which light is produced
  - Anisotropy in direction
  - Variation in color
- Some very simple light sources models are standard

Light Sources

- Two aspects of light sources are important for a local shading model:
  - Where is the light coming from (the L vector)?
  - How much light is coming (the I values)?
- Various light source types give different answers to the above questions:
  - Directional: Light from a specific direction
  - Point light source: Light from a specific point
  - Spotlight: Light from a specific point with intensity that depends on the direction

Directional Light

- When light is coming from a distant source
  - light rays are parallel
  - light ray direction is the same everywhere in the scene
  - as if the source were infinitely far away
  - good approximation to sunlight
- Specified by a unit length direction vector, and a color

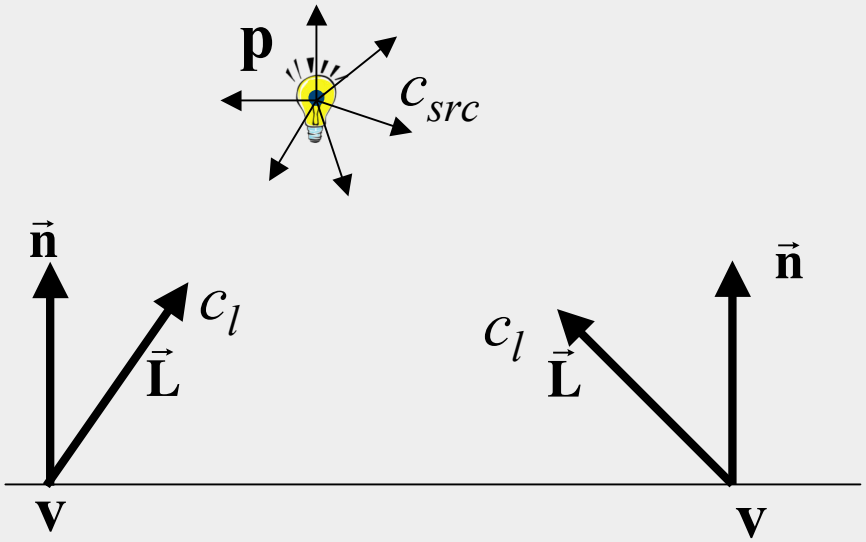


$$\vec{\mathbf{L}} = -\vec{\mathbf{d}}$$

$$c_l = c_{src}$$

Point Lights

- For closer light sources, such as light bulbs
- Model as a point that radiates light in all directions equally
  - Light vector varies across the surface
  - Intensity from a point light source drops off proportionally to the inverse square of the distance from the light



$$\vec{L} = \frac{\mathbf{p} - \mathbf{v}}{|\mathbf{p} - \mathbf{v}|}$$

$$c_l = \frac{c_{src}}{|\mathbf{p} - \mathbf{v}|^2}$$

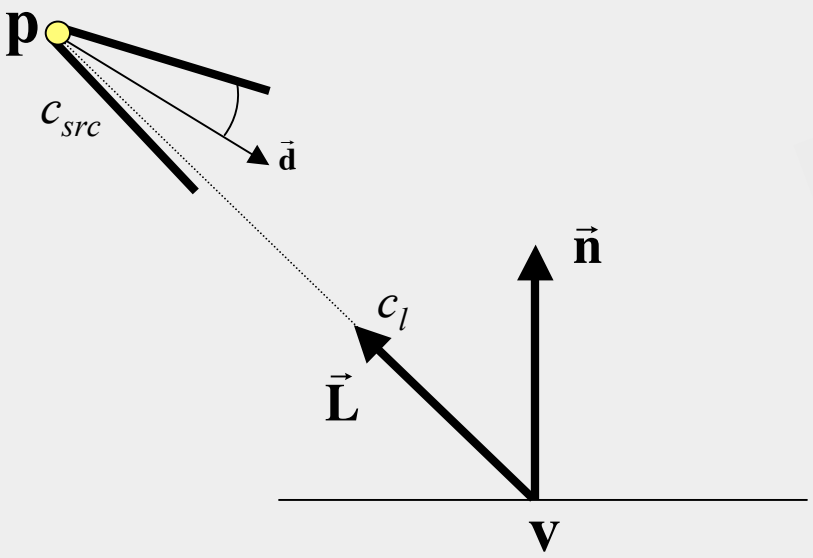
Attenuation

- Sometimes, it is desirable to modify the inverse square falloff behavior of point lights
  - A common (although not physically accurate) model for the distance attenuation is:

$$c_l = \frac{c_{src}}{k_c + k_l \left|\mathbf{p} - \mathbf{v}\right| + k_q \left|\mathbf{p} - \mathbf{v}\right|^2}$$

Spotlights

- Like point source, but intensity depends on direction:
  - Position: the location of the source
  - Spot direction: the center axis of the light
  - Requires falloff parameters:
    - how broad the beam is (cone angle)
    - how light tapers off at edges of he beam (cosine exponent)



$$\vec{\mathbf{L}} = \frac{\mathbf{p} - \mathbf{v}}{|\mathbf{p} - \mathbf{v}|}$$

$$c_l = \begin{cases} 0 & if -\vec{\mathbf{L}} \cdot \vec{\mathbf{d}} < \cos(\theta_{\max}) \\ c_{src}\left(-\vec{\mathbf{L}} \cdot \vec{\mathbf{d}}\right)^f & otherwise \end{cases}$$

Spotlights