Imatge Sintètica

Ray Tracing for Realistic Image Synthesis

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Lecture 5 - Global Illumination

2017/2018

Class Outline

Lecture 5 - Global Illumination

Last Class Summary

The Global Illumination Problem

- Direct Illumination
- Indirect Illumination

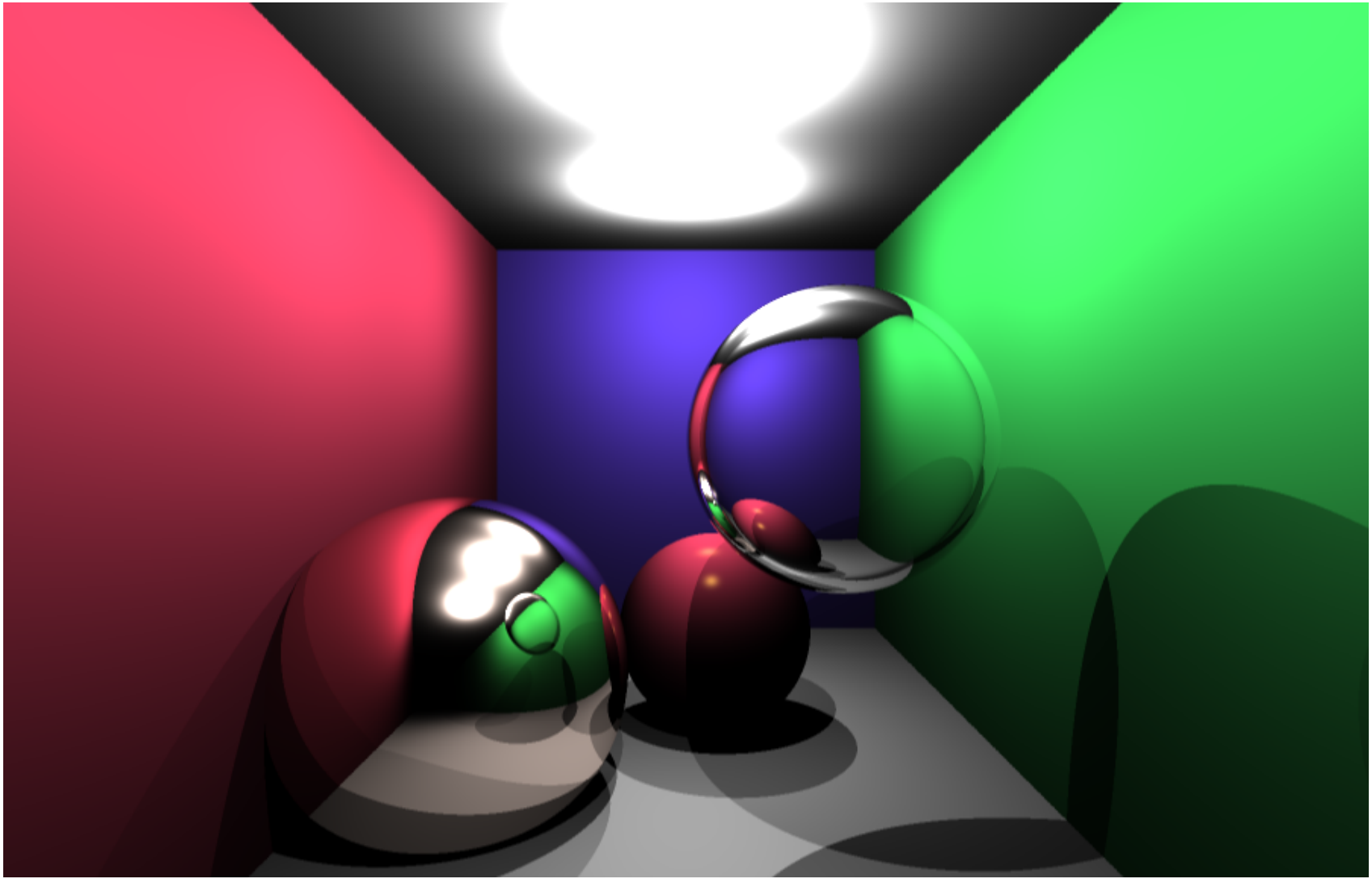
Evaluating the Global Illumination

Next Classes

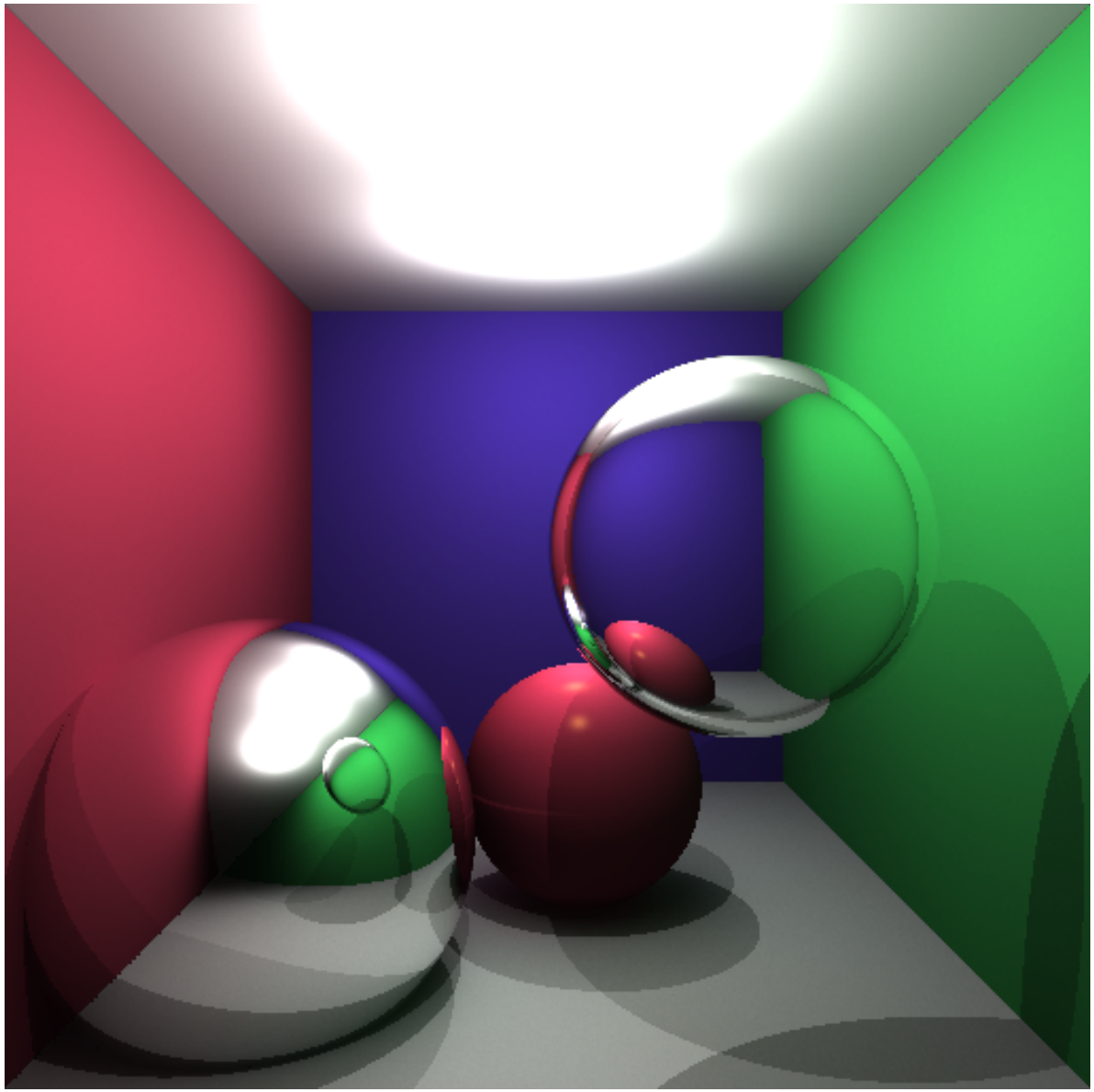
Last Class Summary

- We have learned new light-matter interactions
  - Perfect specular reflections
  - Perfect specular refractions
- We have learned new types of ray-object intersections
  - Ray-plane intersection (infinite plane)
  - Ray-triangle intersection

Last Assignment Result (A4)



Next Assignment Result (A5)



Section 2

The Global Illumination Problem

Global Illumination

- Image rendered with direct + indirect = global

Direct

Indirect

Direct + Indirect

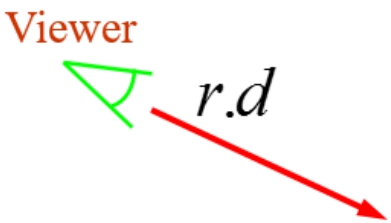
Global Illumination

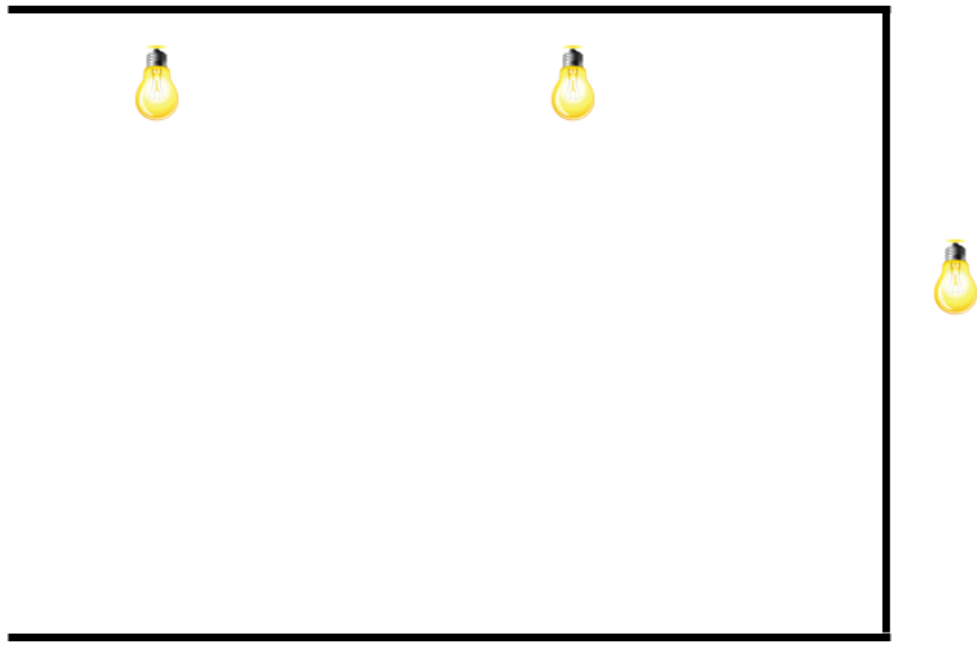
- Image rendered with direct + indirect = global

Subsection 1

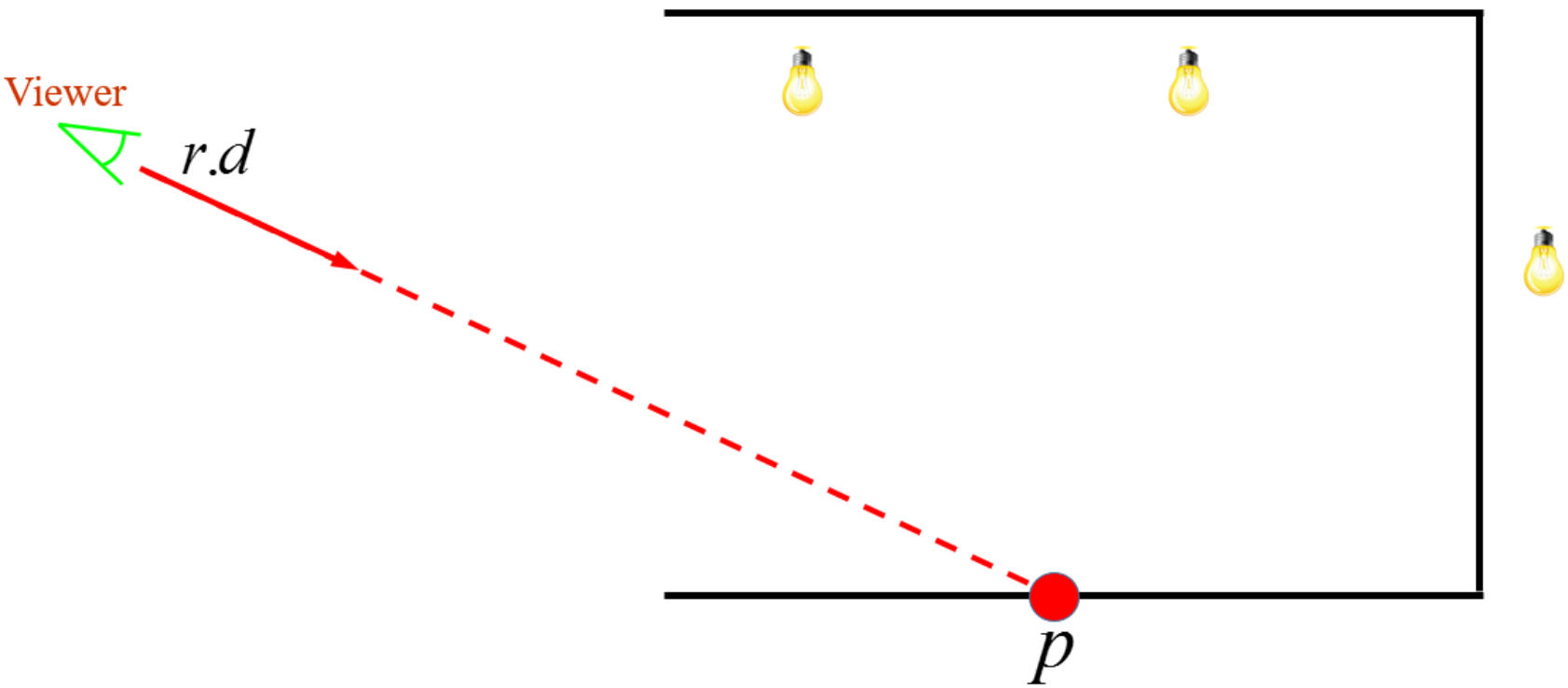
Direct Illumination

Direct Illumination

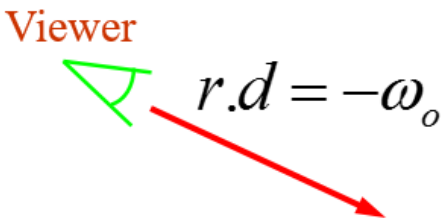


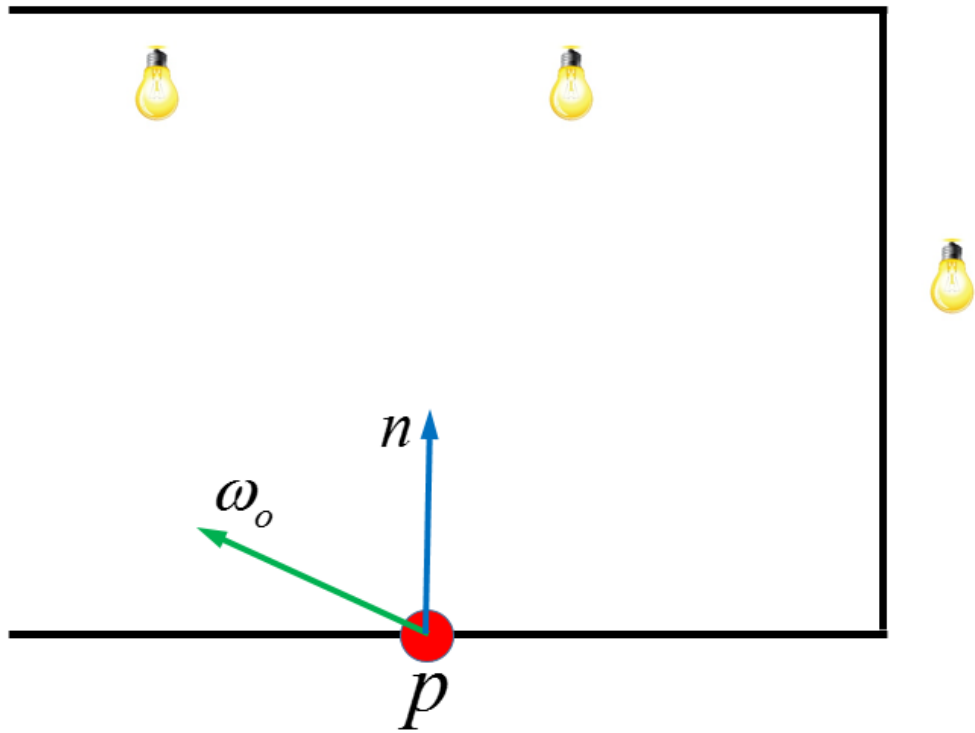


Direct Illumination



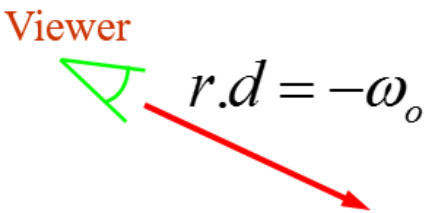
Direct Illumination

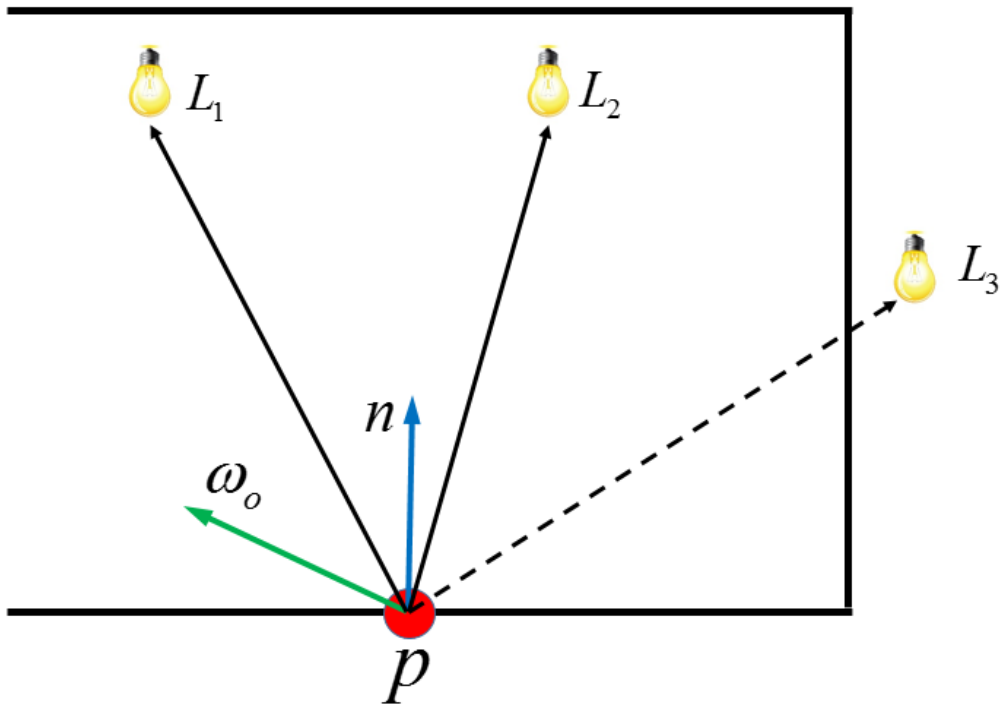




$$L_o^{dir}(\mathbf{p}, \omega_o) = ?$$

Direct Illumination

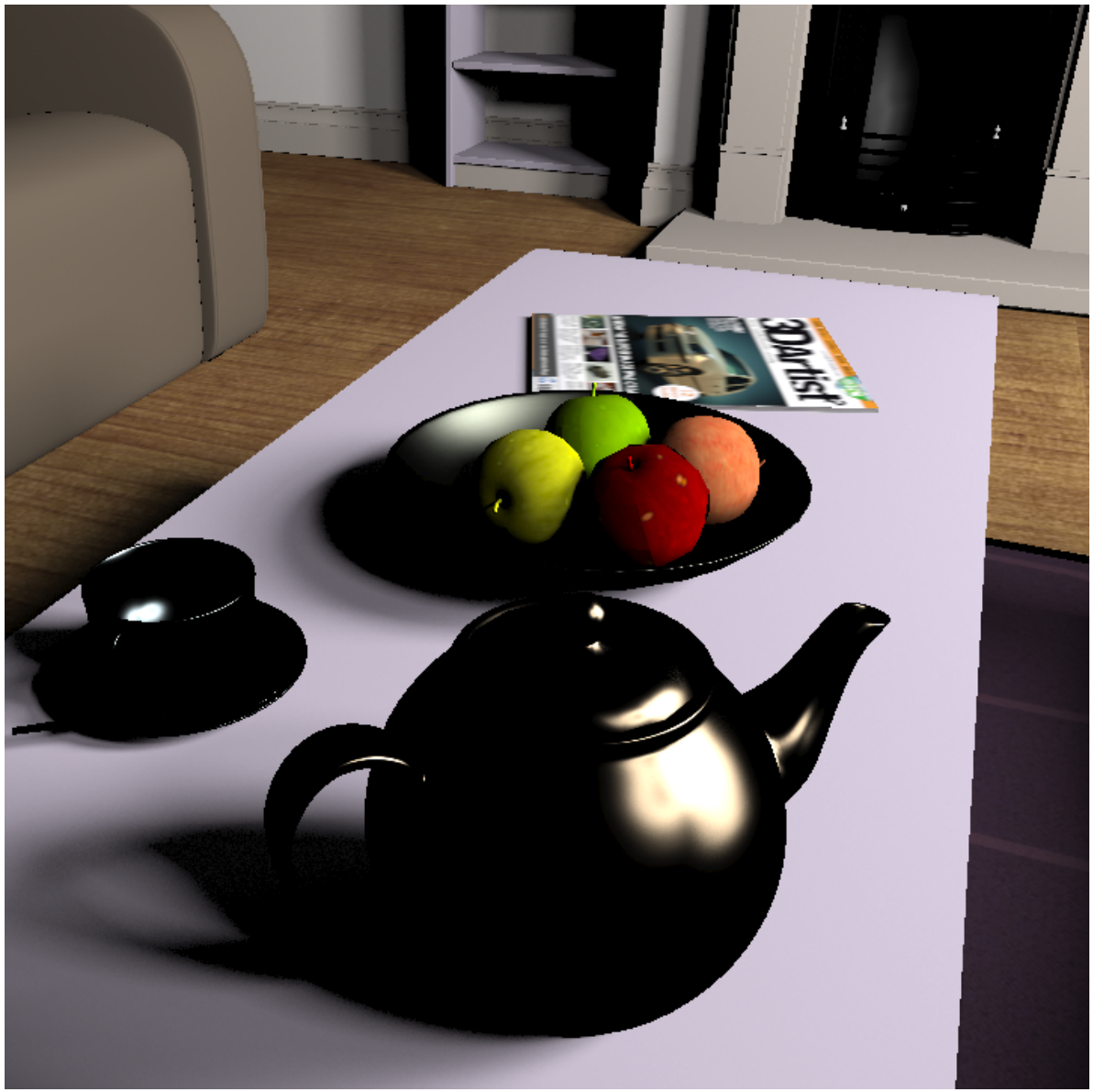




$$L_o^{dir}(\mathbf{p}, \omega_o) = \sum_{s=1}^{3} L_i^s(\mathbf{p}) r(\omega_i^s, \omega_o) V^s(\mathbf{p})$$

Direct Illumination

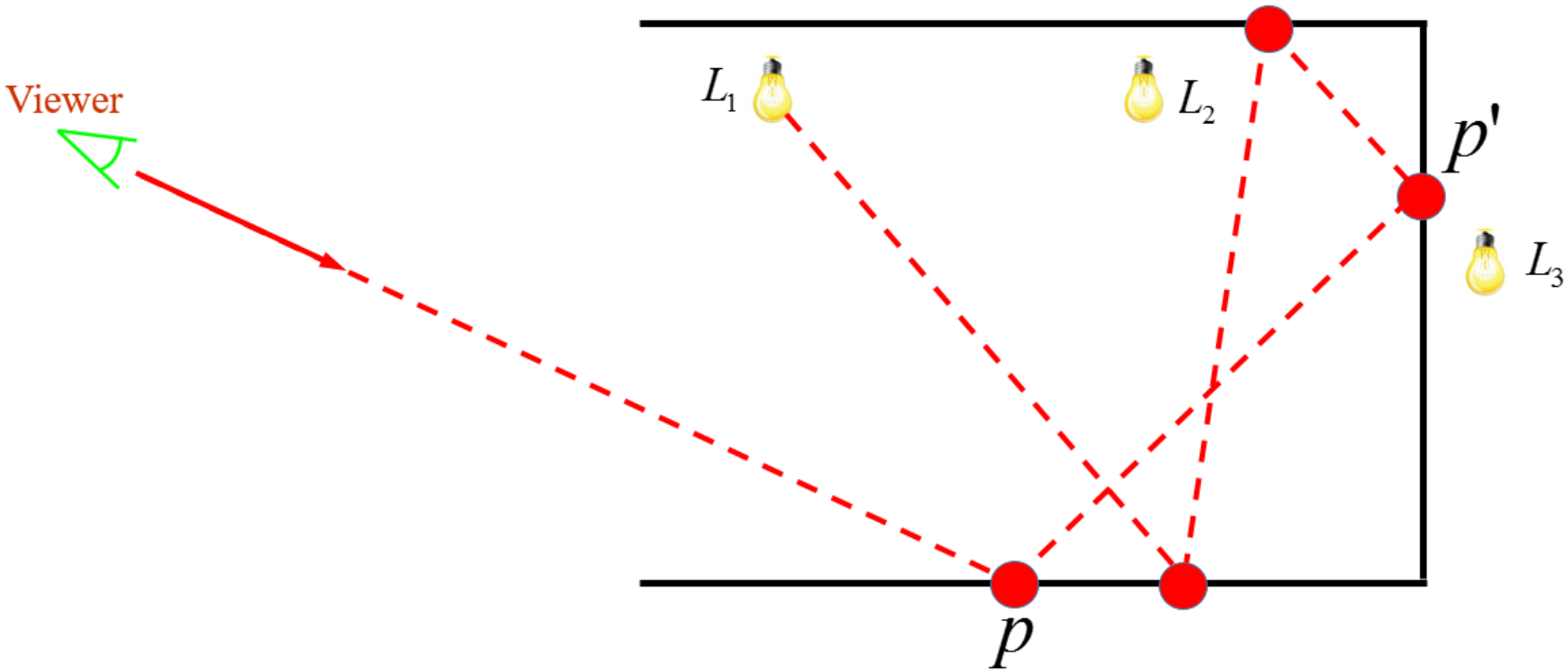
- Image rendered with direct only



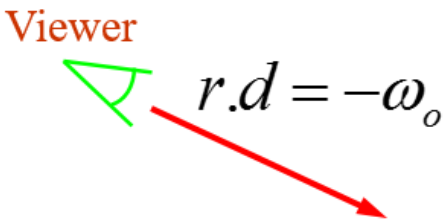
Subsection 2

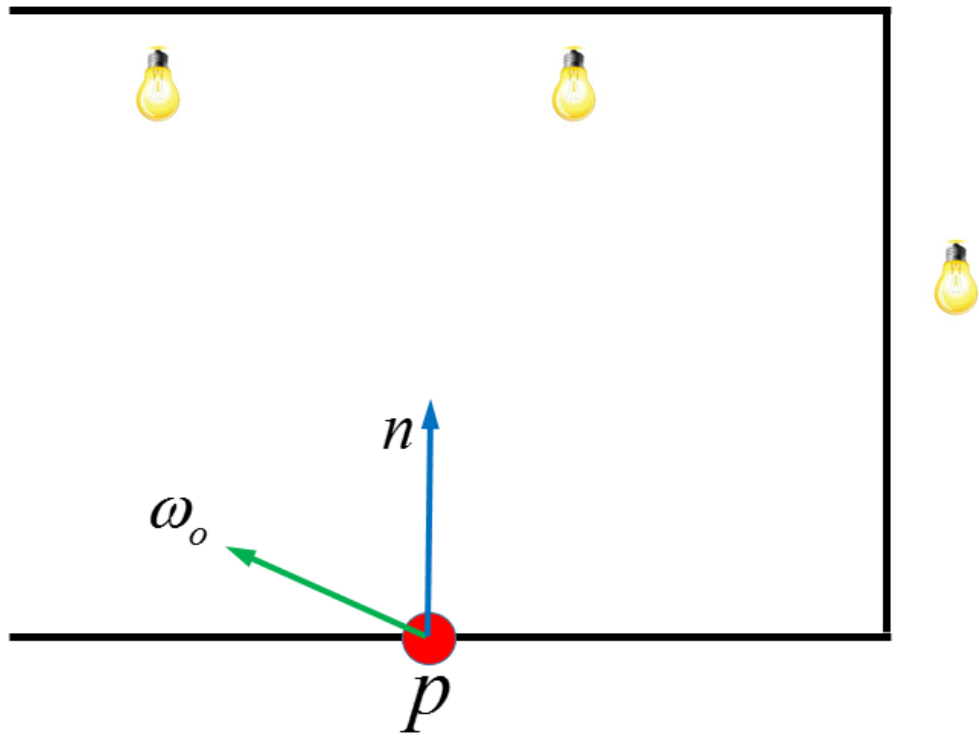
Indirect Illumination

Indirect Illumination



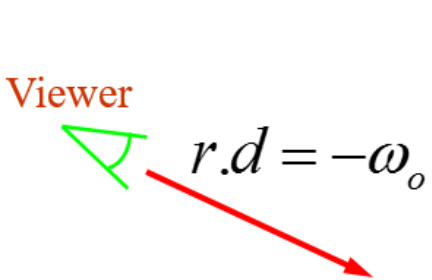
Indirect Illumination

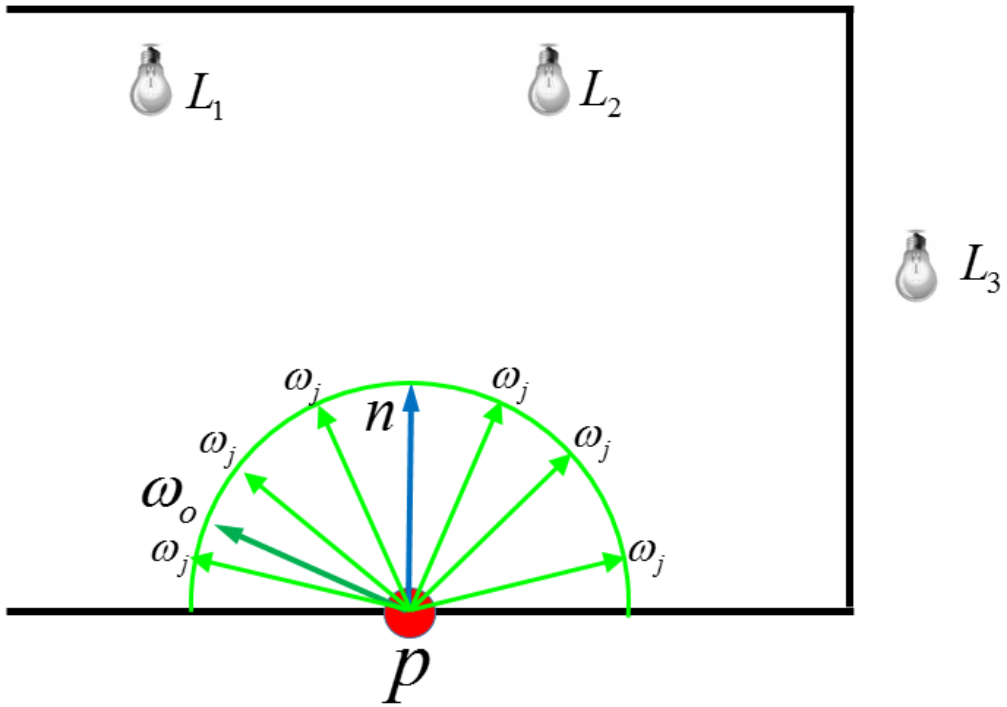




$$L_o^{ind}(\mathbf{p}, \omega_o) = ?$$

Indirect Illumination

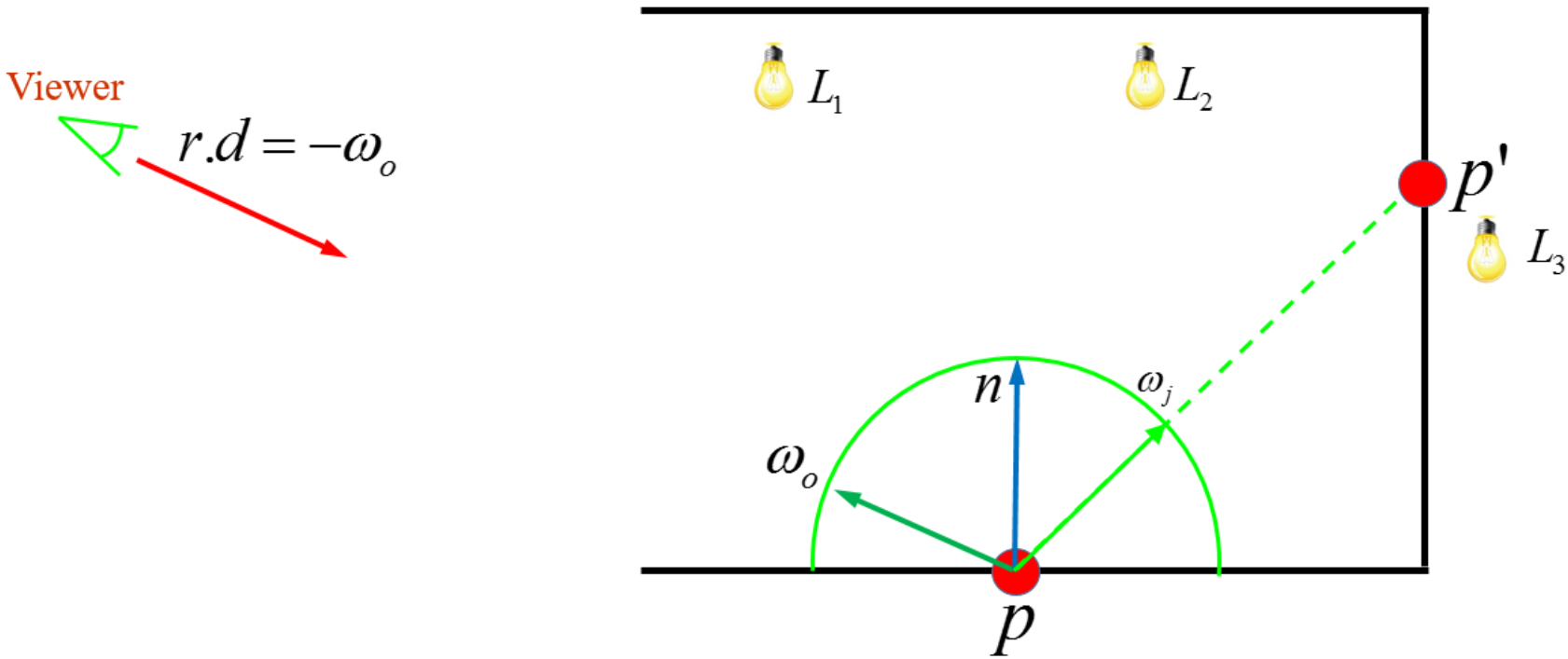




$$L_o^{ind}(\mathbf{p}, \omega_o) = \frac{1}{2\pi n} \sum_{j=1}^{n} L_i(\mathbf{p}, \omega_j) r(\omega_j, \omega_o)$$

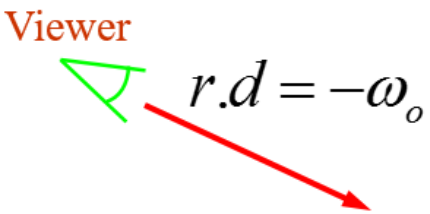
$$L_i(\mathbf{p}, \omega_j) = ?$$

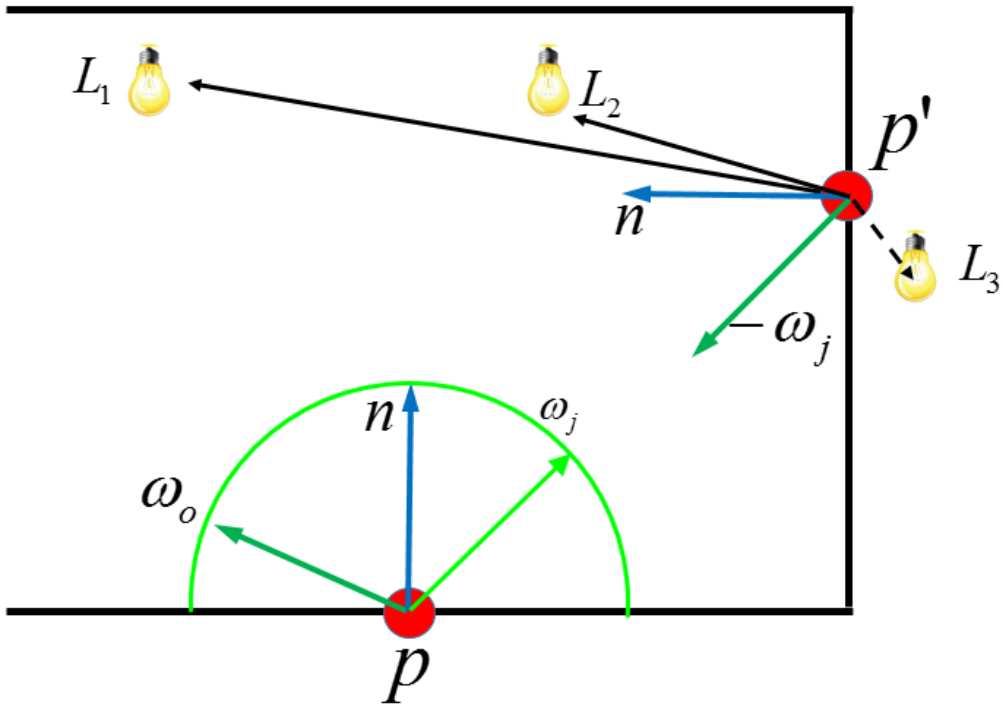
Indirect Illumination



$$L_i(\mathbf{p}, \omega_j) = L_o(\mathbf{p}', -\omega_j) = L_o^{dir}(\mathbf{p}', -\omega_j) + L_o^{ind}(\mathbf{p}', -\omega_j)$$

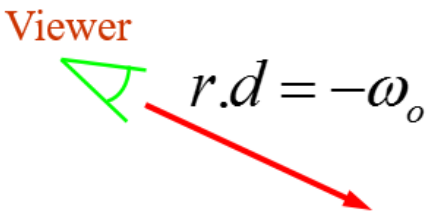
Indirect Illumination

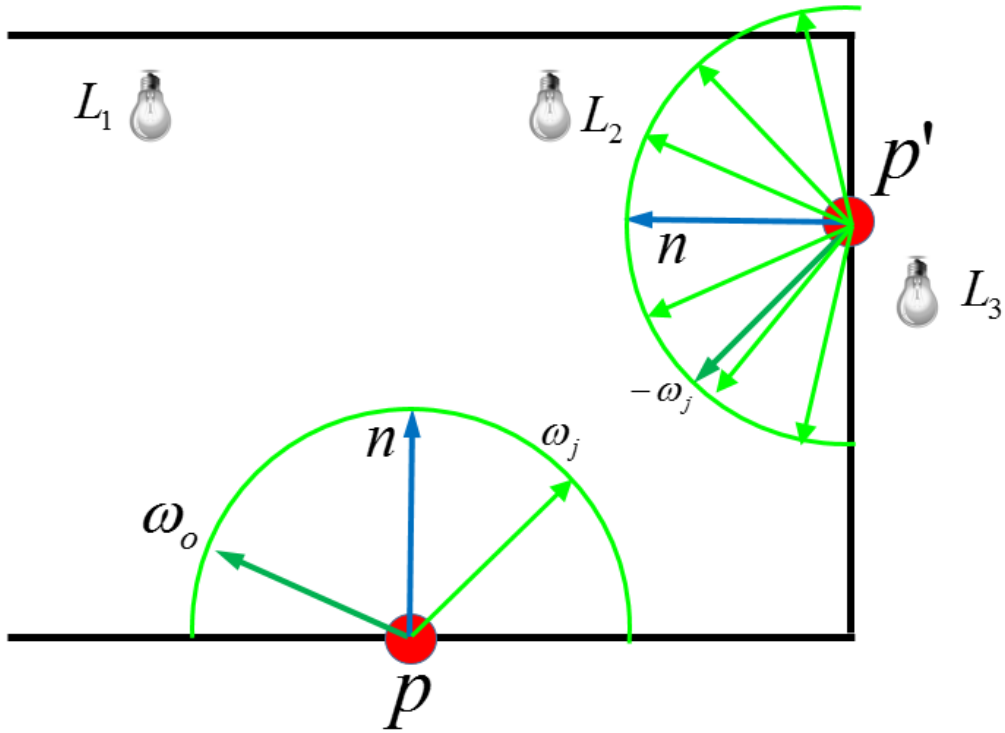




$$L_o^{dir}(\mathbf{p}', -\omega_j) = \sum_{s=1}^{3} L_i^s(\mathbf{p}') r(\omega_i^s, -\omega_j) V^s(\mathbf{p}')$$

Indirect Illumination





$$L_o^{ind}(\mathbf{p}', -\omega_j) = \frac{1}{2\pi n} \sum_{k=1}^{n} L_i(\mathbf{p}', \omega_k) r(\omega_k, -\omega_j)$$

Indirect Illumination

- Image rendered with indirect only

The Global Illumination Problem

- Simulate *all* light paths from the light sources to the viewer
- There are infinite light paths with infinite light bounces!
- Impossible to simulate all of them
- Need to use approximated solutions

Section 3

Evaluating the Global Illumination

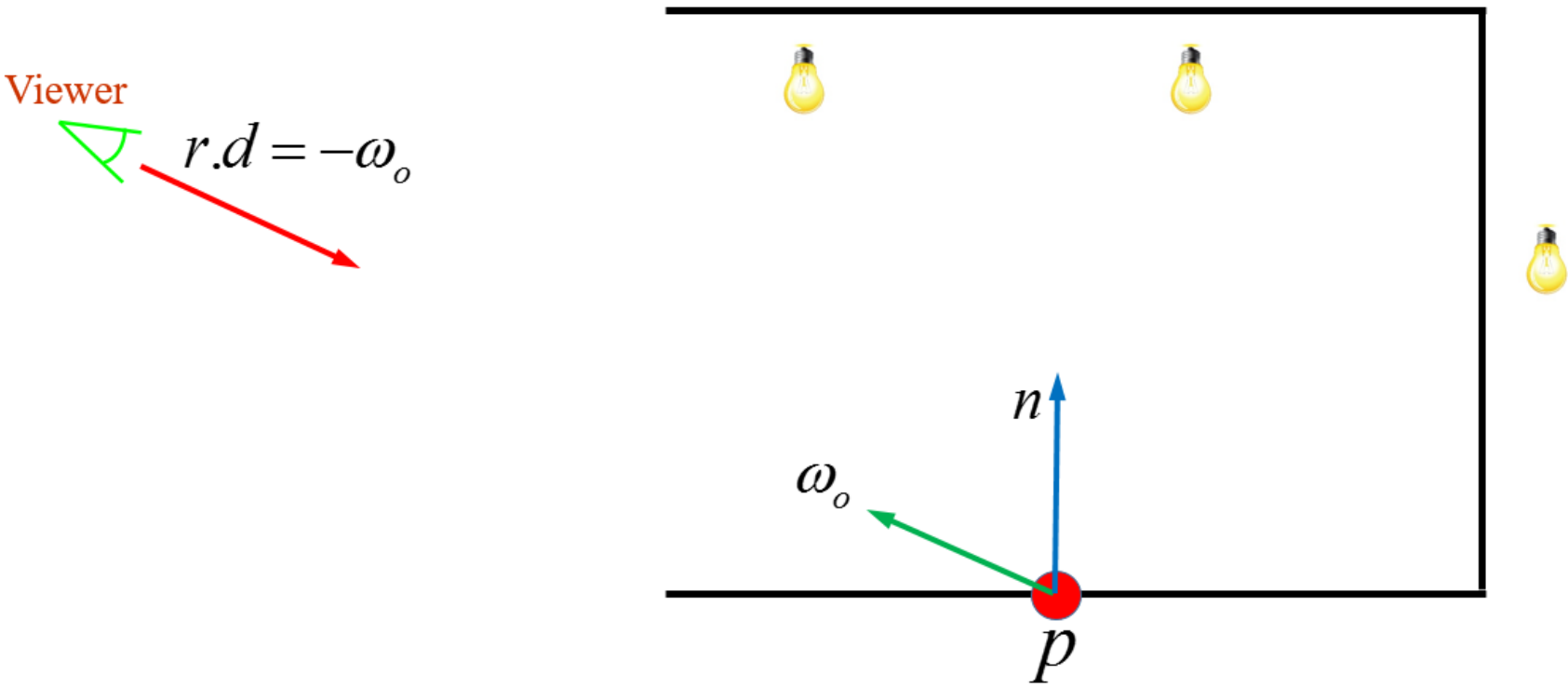
Ambient Term

- The ambient term a_t is a constant (R,G,B) used to account for the indirect illumination arriving at each shading point

$$L_o^{ind}(\mathbf{p}, \omega_o) = k_d \, a_t$$

- The indirect illumination is assumed constant at all shading points
  - No need to send secondary rays (efficient)
  - The indirect light paths are not explicitly simulated
  - No color bleeding (when an object is colored by the reflection of colored light from nearby surfaces)

Ambient Term



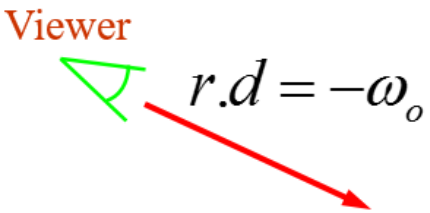
$$L_o(\mathbf{p}, \omega_o) = L_o^{dir}(\mathbf{p}, \omega_o) + L_o^{ind}(\mathbf{p}, \omega_o)$$

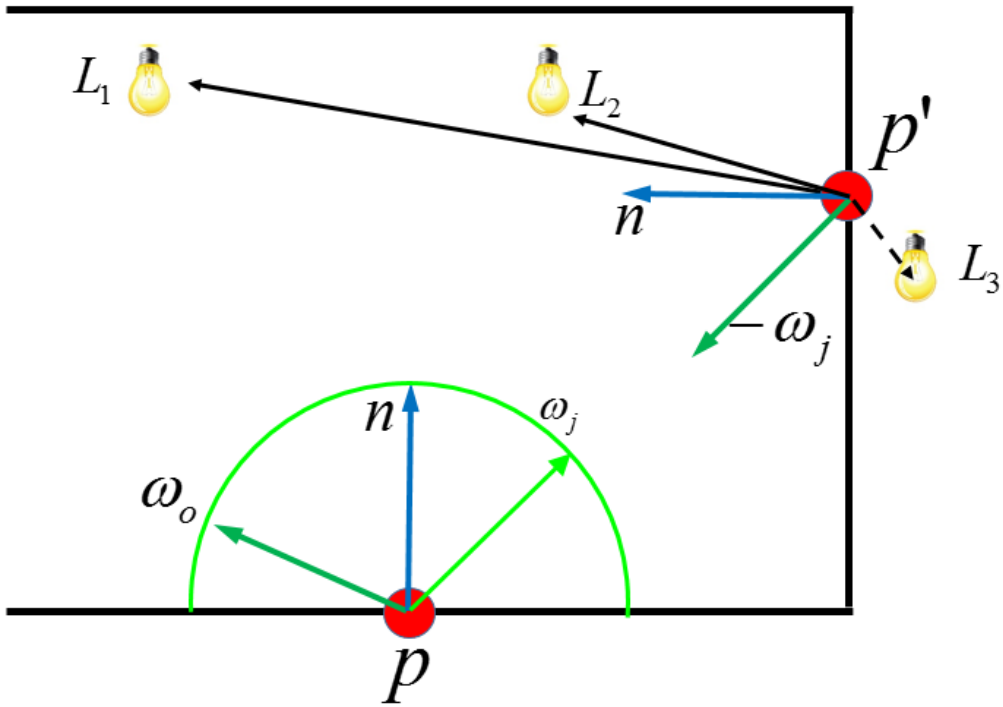
$$L_o^{ind}(\mathbf{p}, \omega_o) = k_d \, a_t$$

2 Bounces with Ambient Term

- Alternative: only compute indirect illumination for intersection points of camera rays
  - Compromise between quality and efficiency
  - Only 2 bounces of light are explicitly simulated
  - Allows for color bleeding phenomena

2 Bounces with Ambient Term





$$L_o(\mathbf{p}', -\omega_j) = \sum_{s=1}^{3} L_i^s(\mathbf{p}') r(\omega_i^s, -\omega_j) V^s(\mathbf{p}') + k_d\, a_t$$

Lecture Summary

- We have learned what is the Global Illumination problem (GI)
- We have learned two strategies, based on the use of an ambient term, to provide an approximate solution to the GI problem
- We will use assignment 5 to implement these strategies and consolidate the new concepts

A Glance on the Next Classes

- Anti-Aliasing
- Projects Presentation
  - Brief overview of a set of proposed projects