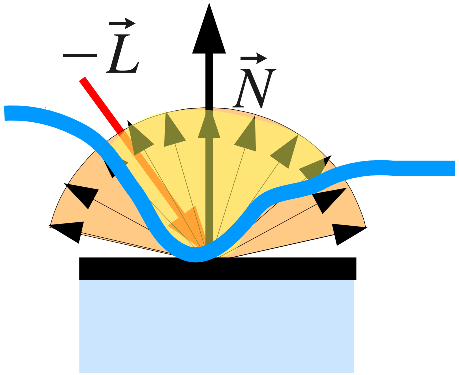
CS 775: Advanced Computer Graphics

Lecture 5 : Ambient Occlusion, Photon Mapping and Point-based Global Illumination

Ambient Occlusion

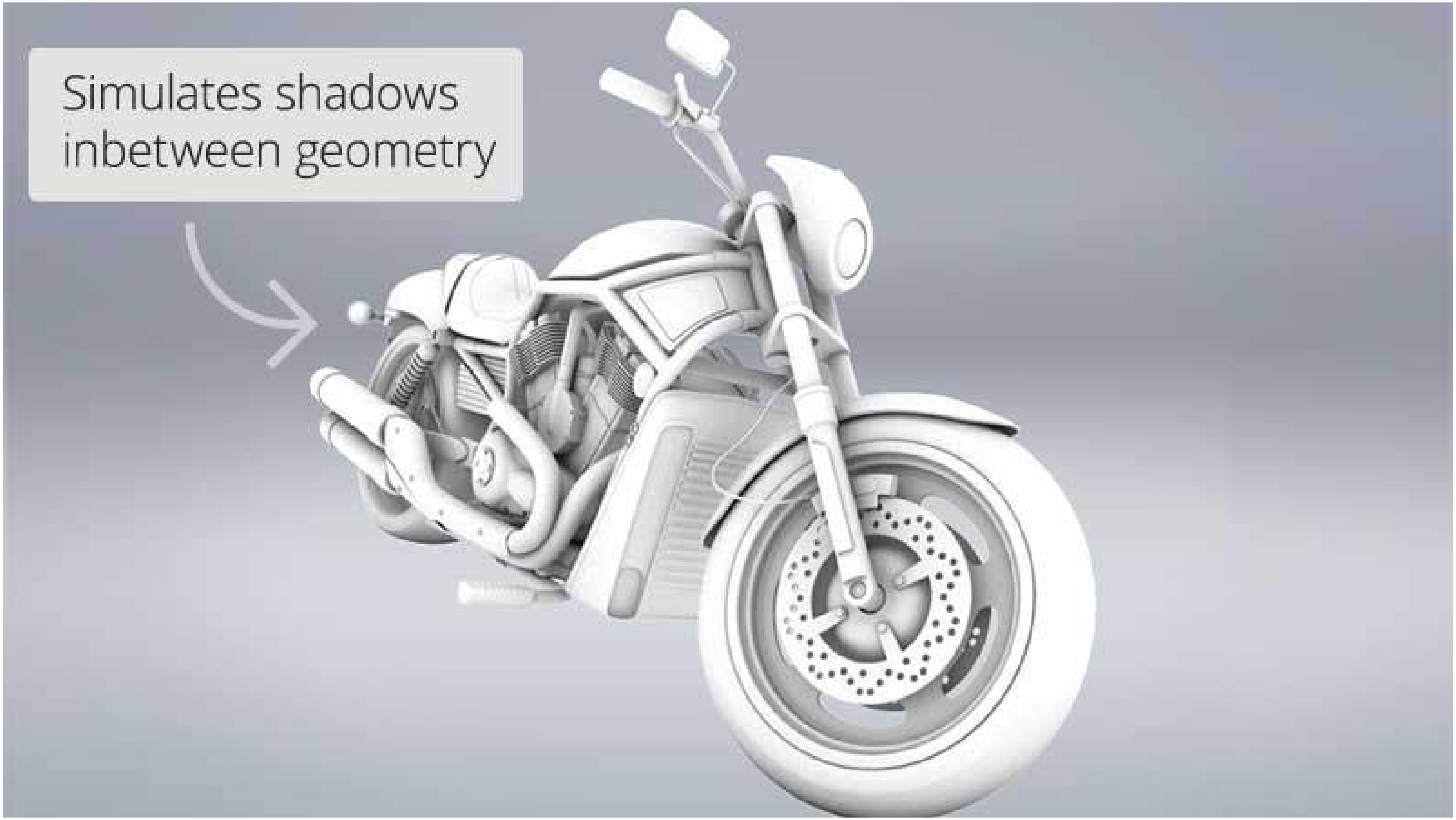
$$A_{\overline{p}} = \frac{1}{\pi} \int_{\Omega} V_{\overline{p},\omega_i} (\hat{n} \cdot \omega_i) \, d\omega$$



- Shadow due to ambient illumination
- How exposed a point is to ambient lighting?
  - Sample with inside-out with Monte-Carlo Techniques
  - Sample with outside-in with multiple renders

https://en.wikipedia.org/wiki/Ambient_occlusion

Ambient Occlusion



http://blog.digitaltutors.com/understanding-ambient-occlusion/

https://support.solidangle.com/display/AFCUG/Ambient+Occlusion

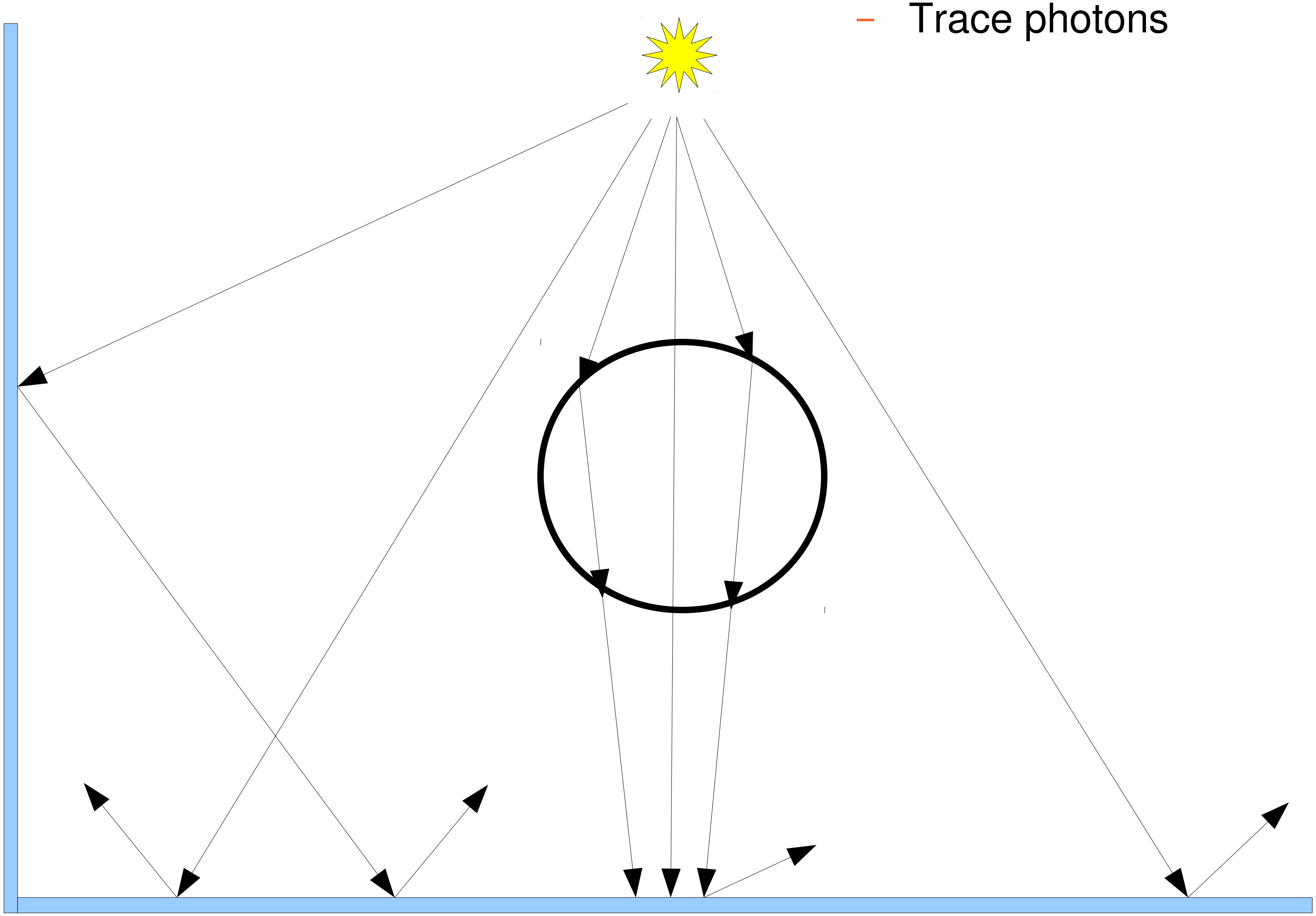
Photon Mapping

$$L_o(p,\omega_o) = L_e(p,\omega_o) + \int_{\Omega} f_r(p,\omega_o,\omega_i) L_i(p,\omega_i)\cos\theta_i \, d\omega_i$$

- Photon Mapping Algorithm
  - Emit photons
  - Trace photons
  - Store photons
    - Caustic photon map
    - Global photon map
  - Gather photons

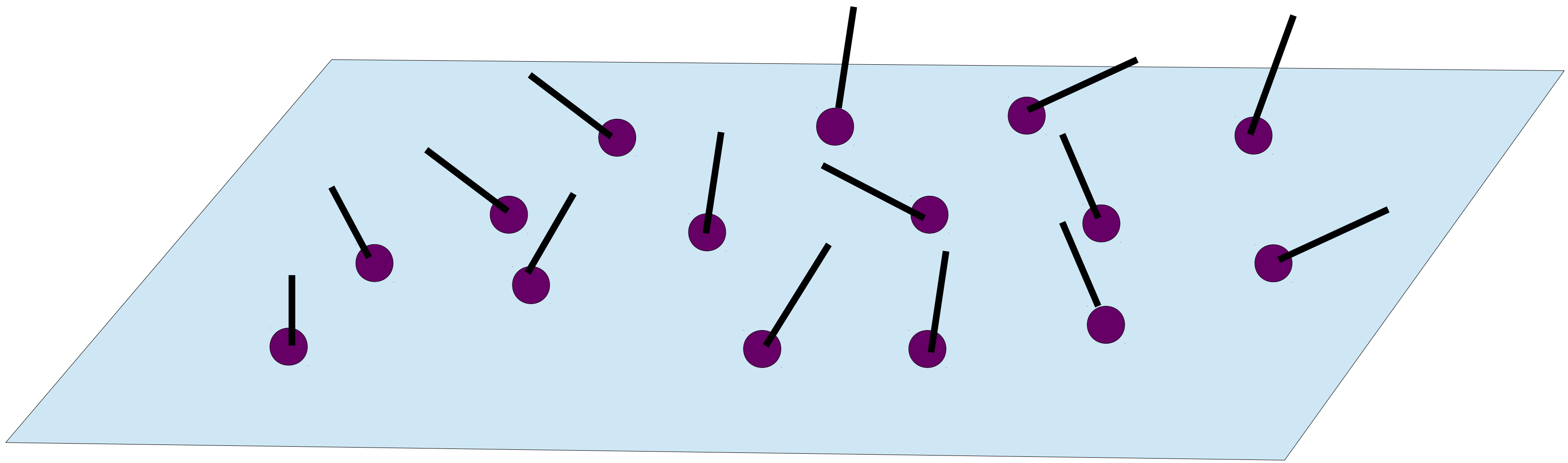
Photon Mapping

- Emit photons
- Trace photons



Photon Mapping

- Store photons
  - Caustic photon map
  - Global photon map



Photon Mapping

- Reflected Radiance Estimate

$$L_r(p,\omega_o)=\int_{\Omega} f_r(p,\omega_o,\omega_i) L_i(p,\omega_i)\cos\theta_i \, d\omega_i$$

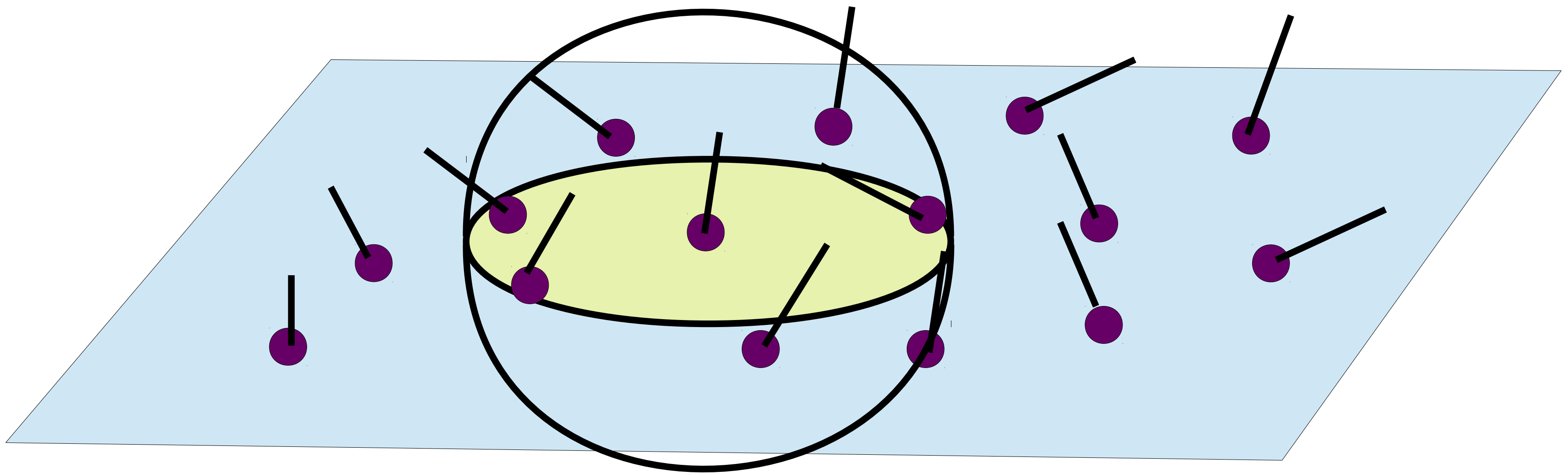
$$L_r(p,\omega_o)=\int_{\Omega} f_r(p,\omega_o,\omega_i) \frac{d\Phi^2(p,\omega_i)}{\cos\theta_i \, d\omega_i \, dA_i}\cos\theta_i \, d\omega_i$$

$$L_r(p,\omega_o)=\int f_r(p,\omega_o,\omega_i) \frac{d\Phi^2(p,\omega_i)}{dA_i}$$

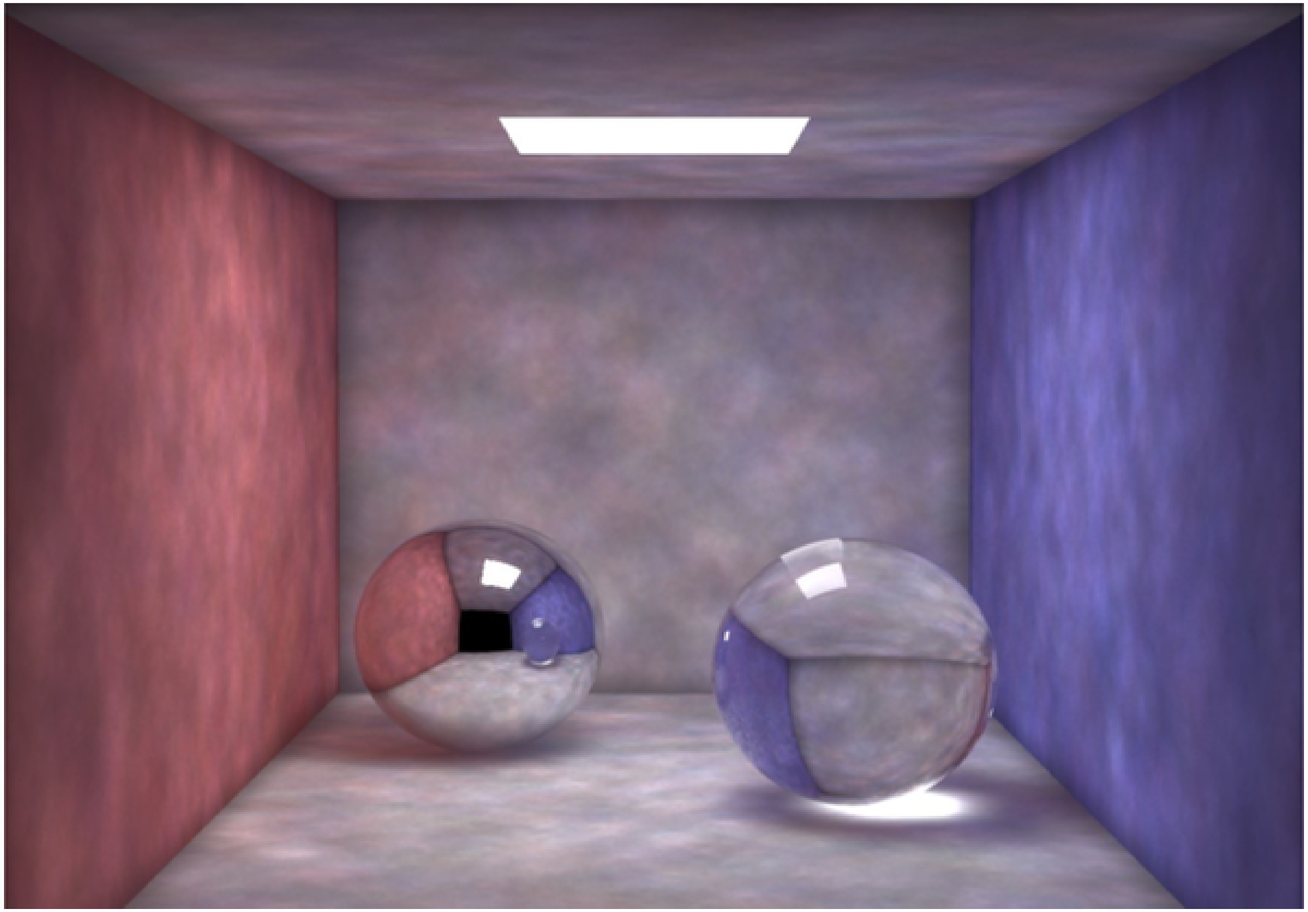
$$L_r(p,\omega_o)\approx\sum_{p=1}^{n} f_r(p,\omega_o,\omega_{ip}) \frac{\Delta\Phi^2(p,\omega_{ip})}{\pi r^2}$$

Photon Mapping

- Gather Photons



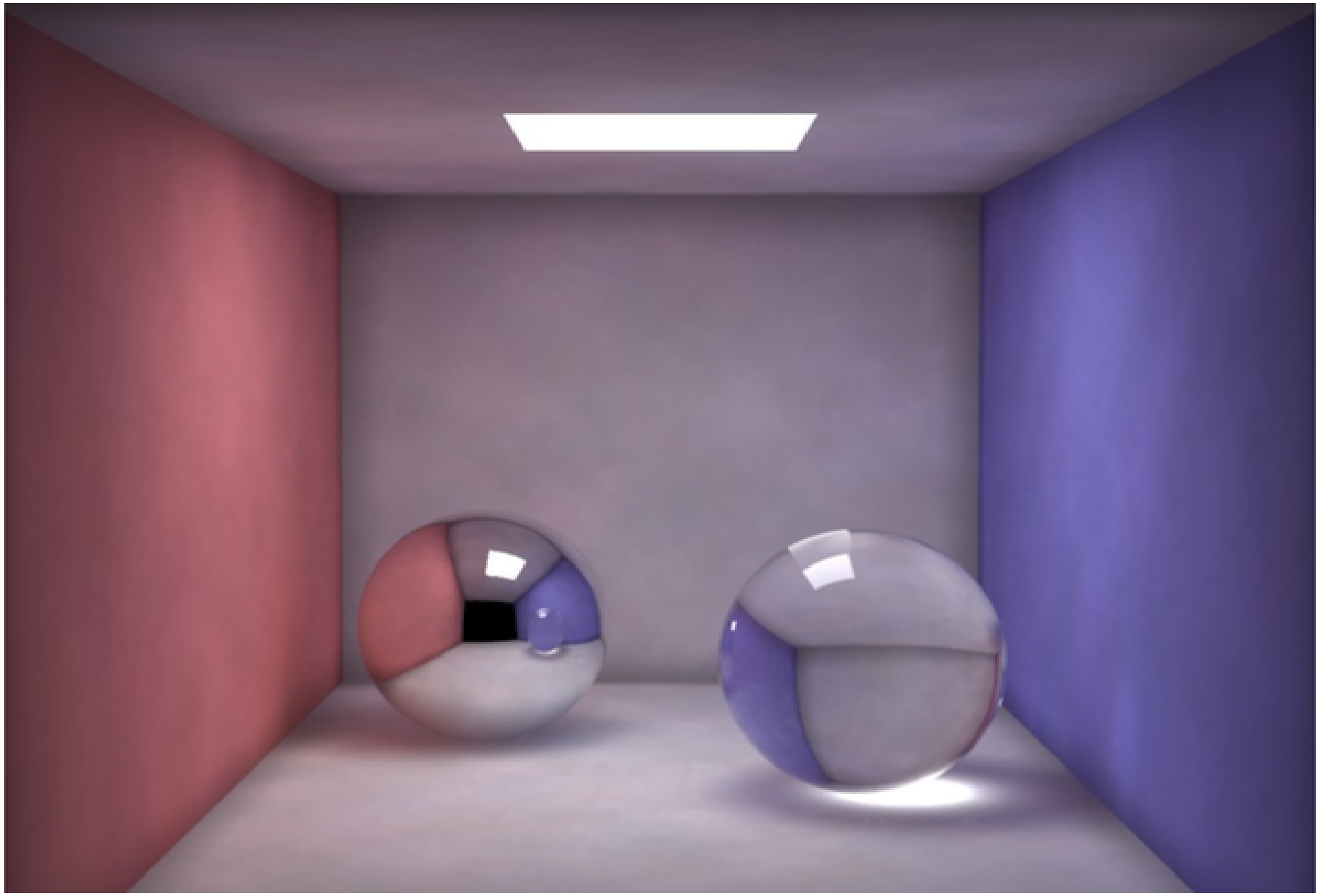
Photon Mapping



- 100000 photons, 50 photons in radiance estimate

http://graphics.stanford.edu/courses/cs348b/lecture/biased

Photon Mapping



– 500000 photons, 500 photons in radiance estimate

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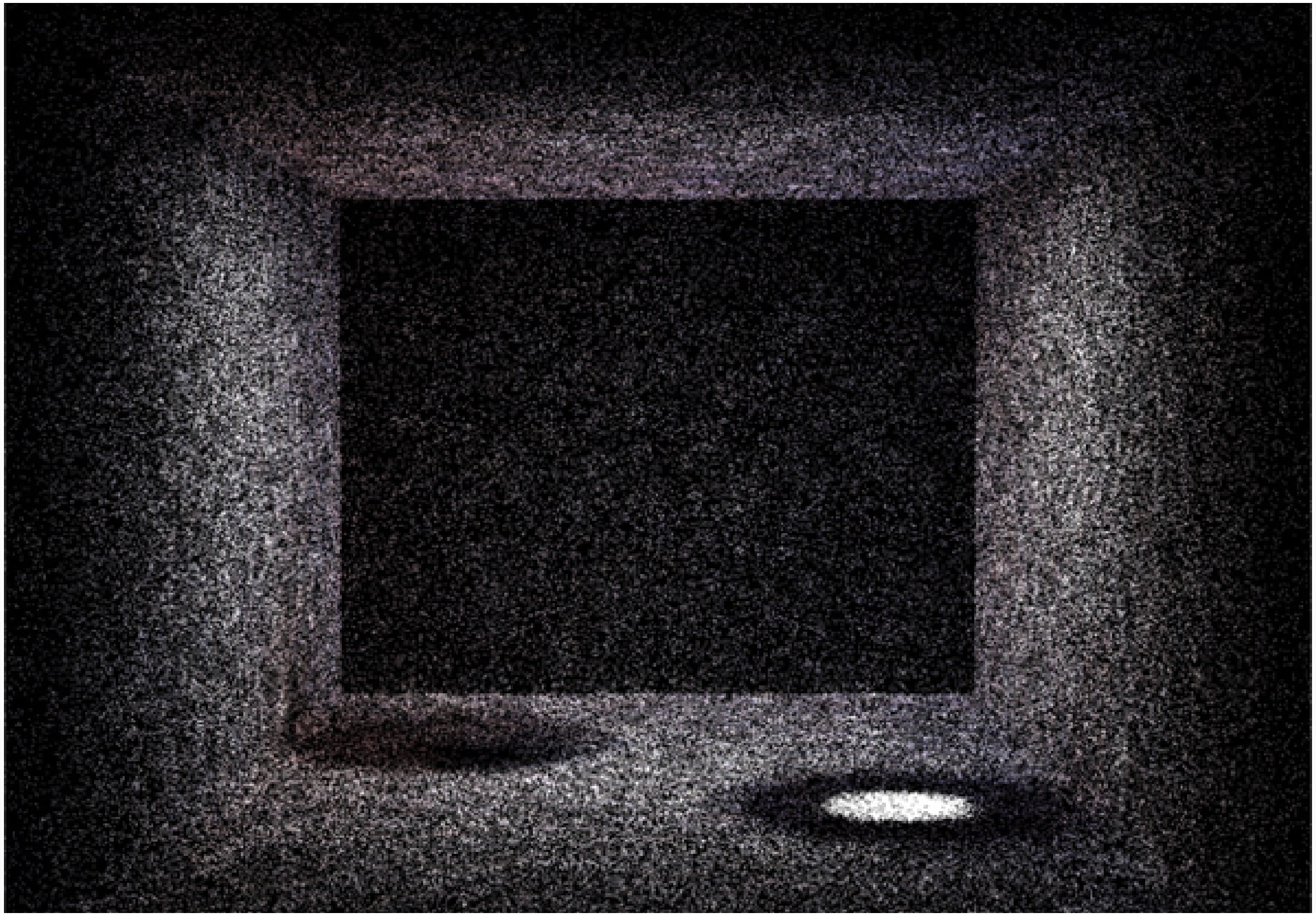
Photon Mapping



- 200000 global photons

http://graphics.stanford.edu/courses/cs348b/lecture/biased

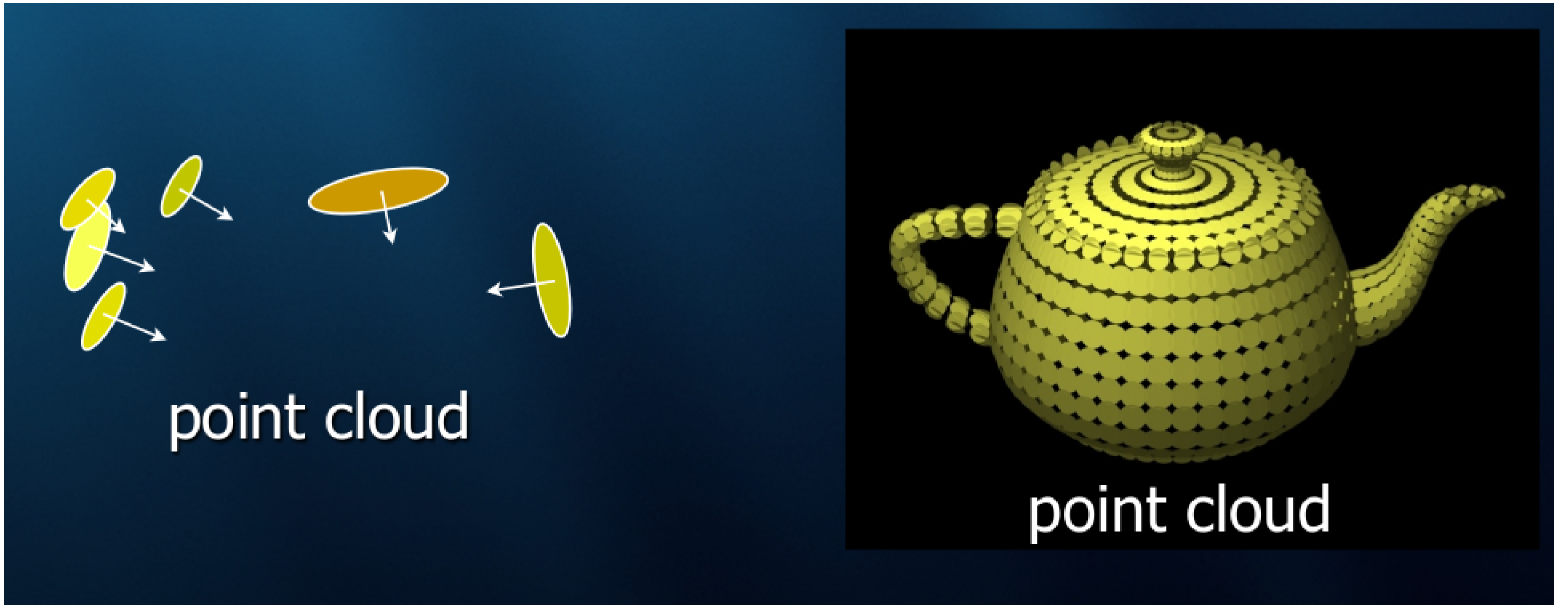
Photon Mapping

https://graphics.stanford.edu/courses/cs348b-competition/cs348b-02/brasket_deleon/

Point-based GI

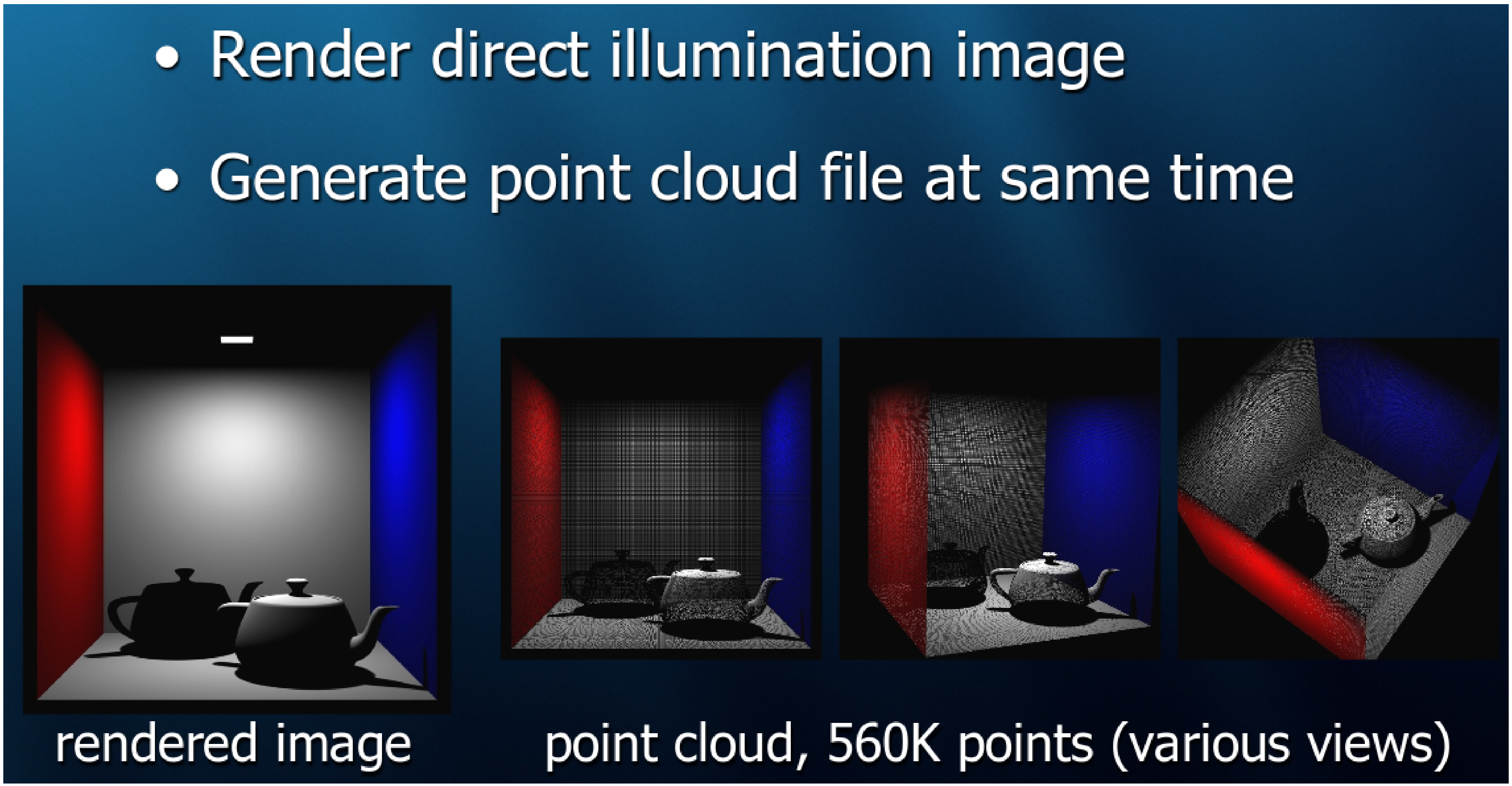
- Divide scene into surfels
- Each surfel is a small disk – point, radius, normal, outgoing radiance
- Record direct illumination on these surfels
- Splat these on the hemisphere around a point in the gather phase and add to compute GI

Point-based GI



Point-Based Global Illumination for Movie Production. Per Christensen. Pixar Animation Studios. SIGGRAPH 2010 Course

Point-based GI



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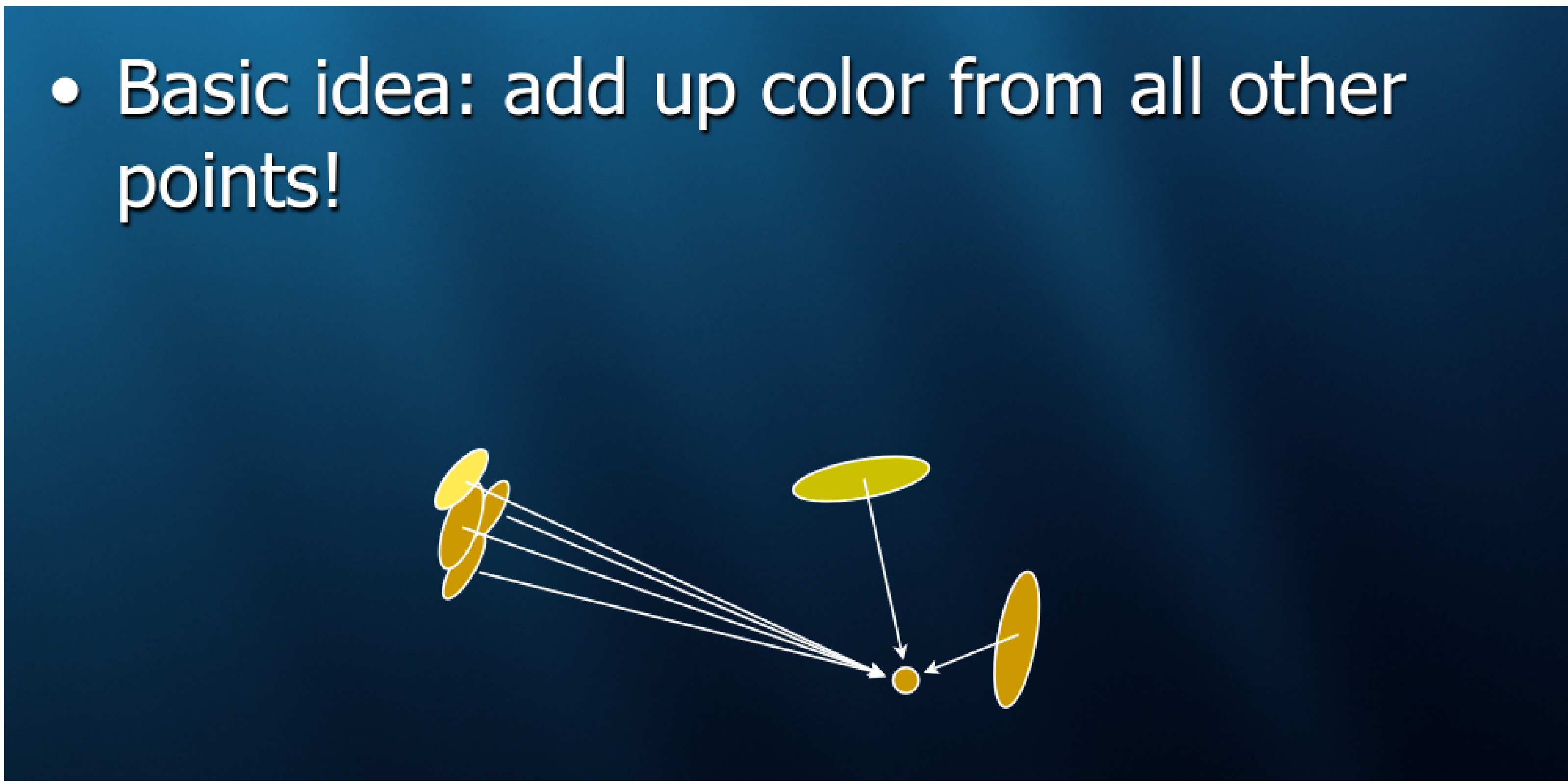
Point-based GI



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Point-based GI

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Consistency and Bias

- Unbiased – produces correct image on average.

$$E[X] = \int \ldots$$

- Consistent- image approaches correct image as some parameter is increased.

$$\lim_{N \to \infty} E[X] = \int \ldots$$

Consistency and Bias

- Biased estimate can be good.
  - Can have lower variance than unbiased estimate, and may look better.
- Read

  http://www.cs.columbia.edu/~keenan/Projects/Other/BiasInRendering.pdf