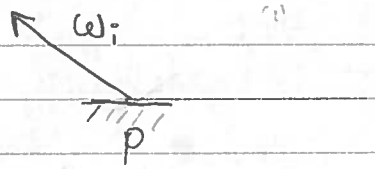
PA2

- It's long. Start early.
- Various integrator, end at full path tracing.
- Learns about sampling strategy and how to combine them with MIS

Emitter Interface

- Look at PBRT for inspiration
- Or, look at BSDF and PhaseFunction.
- Required functionality

(1) Evaluation: given point p and direction ω how much radiance from light source come through ω_i to p?



(2) Sampling: given point p, sample a direction ω that light from emitter comes from

(3) PDF evaluation: given p and ω (already sampled) find the pdf of sampling ω.

- Look at BSDFQueryRecord & PhaseQueryRecord for ideas for interface.
- Your code should put extra info in the record to make sure the emitter can evaluate pdf even if no sampling has been done.

Emitter implementations

- Distant light: Just sample the direction in a straightforward way. (Don't forget to transform!)
- Area light:

① Sample a point on the mesh

⇒ Use the stuff in the note.

② Don't forget to convert to solid angle PDF!

⇒ You need the normal at sampled point for that.

Shading

- BSDF is evaluated in local coordinate!
- Make sure to convert ω_i and ω_o into local coordinates with `shFrame.toLocal` before giving it to BSDF

Scene

- You should make sure the scene knows how to sample the light sources

① Select a light source uniformly

② Let the light source samples a direction

- Scene should also know how to compute PDF of a sampled direction

(1) What is the prob of a particular light source being selected?

(2) What is the probability of light source selects a direction?

Direct Material Sampling

- Careful: BRDF sampling already has cosine factor and pdf built in!

- No need to compute these two things in this integrator.

Microfacet BSDF

- Two modes: Diffuse
  Microfacet.

- To sample select mode first.
  Then sample each mode.

- Compute probability correctly: Don't forget to add the pdf of both modes

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Important: This only do direct illumination. If your ray does not hit a light source, then don't do anything.

Multiple Importance Sampling

- Instead of shooting 1 ray, you shoot 2 rays.
  1. One with emitter sampling
  2. The other with BSDF sampling.
- For each sampled direction, you need to compute
  1. pdf of being sampled with emitter sampling
  2. pdf of being sampled with BSDF sampling

  Then compute MIS weight.
- Important: There are 2 types of BSDF
  1. Discrete (with Dirac δ) < Mirror, Dielectric
  2. Continuous < Diffuse, Microfacet.
- You cannot evaluate, compute pdf of discrete BSDF They will always return 0.
- You only sample it.
- This means, for discrete BSDF, emitter sampling doesn't work. → Don't do it.
- In BSDF sampling, don't compute MIS weight. Just add contribution.

Path Tracing

- There's a hell of difference between path_mats / path_mis.
- In path_mats

$$L_o(x,\omega_o) = L_e(x,\omega_o) + \int_{\Omega} f(\omega_i,\omega_o)\, L_i(x,\omega_i) \cos\theta_i \, d\sigma(\omega_i)$$

$$\approx L_e(x,\omega_o) + \frac{f(\omega_i,\omega_o)\cos\theta_i}{p_{mat}(\omega_i)} \underbrace{L_i(x,\omega_i)}_{\text{recurse to find.}}$$

- Implement Russian roulette to get unbiased estimator:

$$Y = \begin{cases} cL_i(x,\omega_i) & \text{if survive} \\ 0 & \text{if die.} \end{cases}$$

$$E[Y] = pcL_i(x,\omega_i)$$

So, $c = 1/p$.

- In path_mis:

$$L_o(x,\omega_o) = L_e(x,\omega_o) + \underbrace{\int_{\Omega} f(\omega_i,\omega_o)\, L_i^{direct}(x,\omega_i)\cos\theta_i \, d\sigma(\omega_i)}_{\text{Estimate with MIS (2 rays)}}$$

$$+ \underbrace{\int_{\Omega} f(\omega_i,\omega_o)\, L_i^{indirect}(x,\omega_i)\cos\theta \, d\sigma(\omega_i)}_{\text{recursive}}$$

1 ray sampled with BSDF sampling

↓

Can reuse the ray already sampled with MIS

- Important: You are estimating $L_i^{indirect}$.

Don't include an emitter term after this because you already did it with MIS.