PA2

- It's long. Start early.
- Various integrators 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 $w$, how much radiance from light source come through $w$ to $p$?

2. Sampling: given point $p$, sample a direction $w$ that light from emitter comes from.

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

- Look at BSDF/Query Record & Phase/Query Record 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.
- 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 $\omega_i$ and $\omega_o$ into local coordinates with $\text{shFrame}_i$ to $\text{Local}$ 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

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
2. Continuous < Dielectric
3. 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

\[ L_0(x, \omega_o) = L_0(x, \omega_o) + \int_{\omega_i} f(\omega_i, \omega_o) L_i(x, \omega_i) \cos \theta_i \, d\omega_i \]

- \[ \approx L_0(x, \omega_o) + f(\omega_i, \omega_o) \cos \theta_i \cdot \frac{L_i(x, \omega_i)}{P_{\text{mat}}(\omega_i)} \]

- 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, \( c = \frac{1}{p} \).

- In path mis:

\[ L_0(x, \omega_o) = L_0(x, \omega_o) + \int_{\omega_i} \left( f(\omega_i, \omega_o) L_i(x, \omega_i) \cos \theta_i \, d\omega_i \right)_{\text{direct}} \]

\[ + \int_{\omega_i} f(\omega_i, \omega_o) L_i(x, \omega_i) \cos \theta_i \, d\omega_i \]

\[ \text{recursive} \]

1 ray, sampled with BSDF sampling

Can reuse the ray already sampled with MIS

Estimate with MIS (2 rays)
Important: You are estimating Li: indirect

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