Advanced Graphics

Assignment-1 (Ray Tracing)

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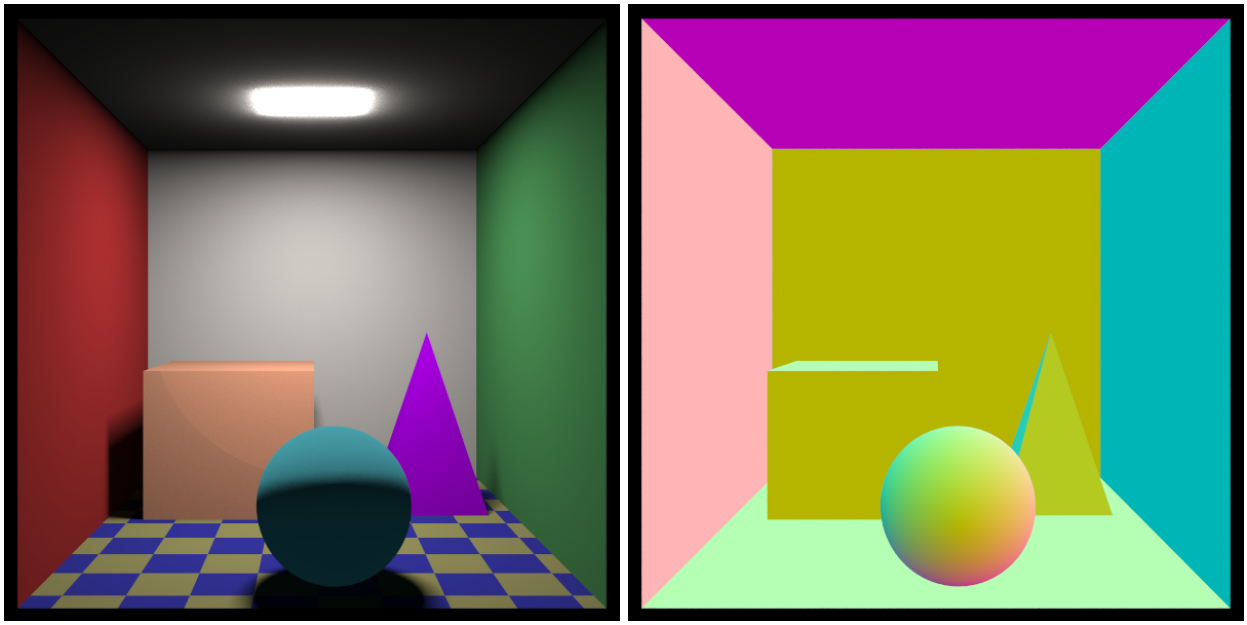
Batch: UG4 CSE

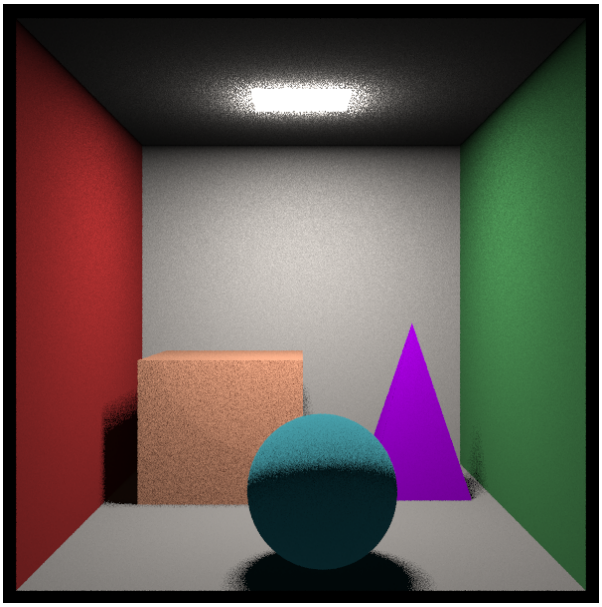
Snapshot of the scene with normals

This scene was rendered at 1000 samples per pixel and took about ten minutes to render.
Each normal in the below rendered image is facing outwards.
Some optimizations while rendering were:

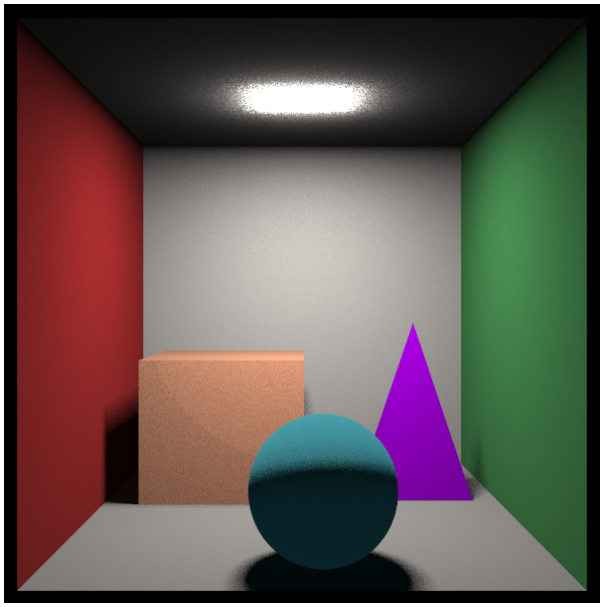
1. BVH
2. Multi threading using OpenMP package in C++.



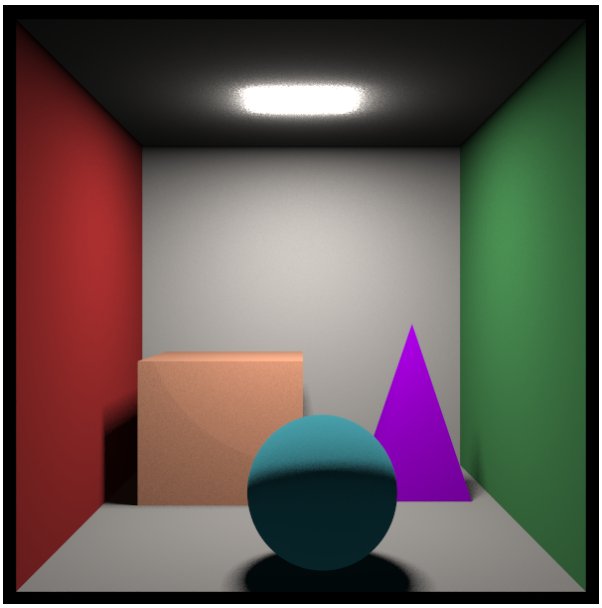
Comparing results with different SPP values



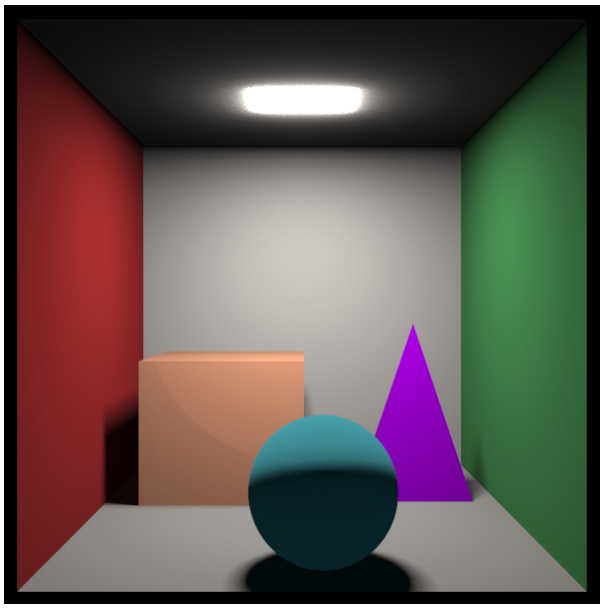
SPP value: 10
A lot of noise in the image



SPP value: 50
A little noise remains on the surfaces.

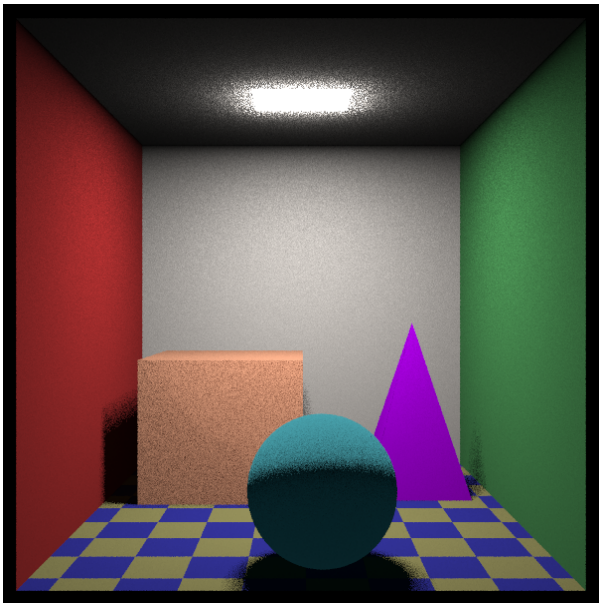


SPP value: 200
Negligible noise on boundaries of surface. Light surface still has some noise.

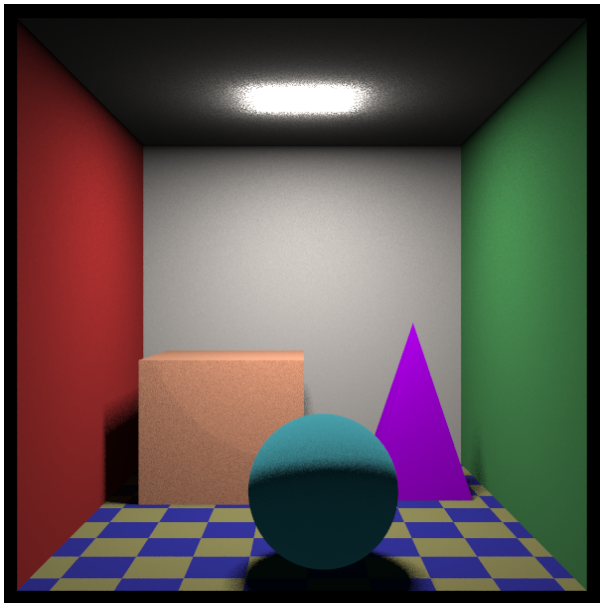


SPP value: 1000
Light surfaces and distribution is much smoother.

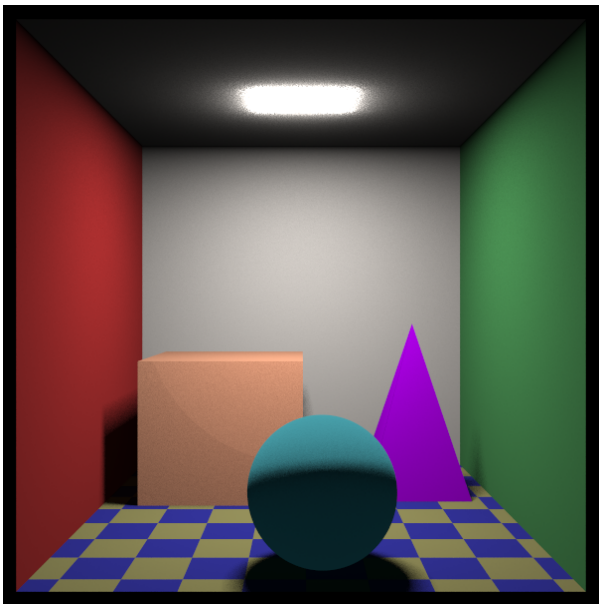
Adding a checkboard texture to the ground



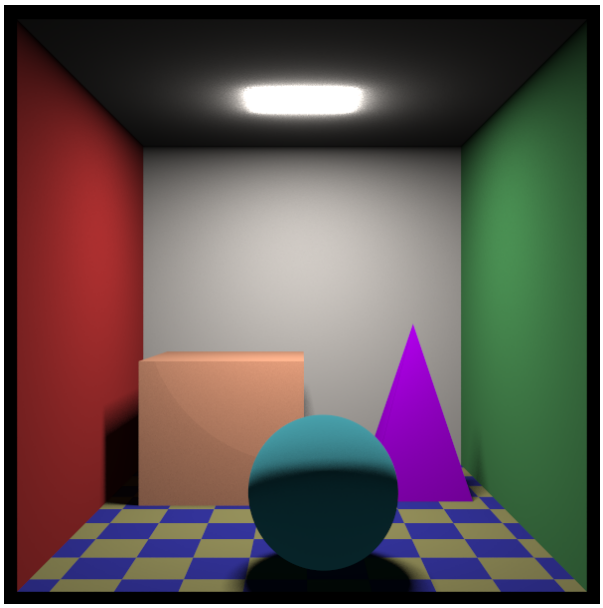
SPP value: 10
A lot of noise in the image



SPP value: 50
A little noise remains on the surfaces.



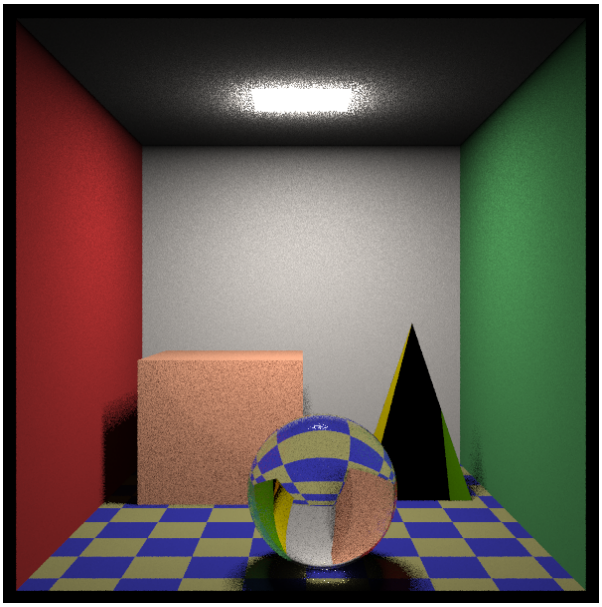
SPP value: 200
Negligible noise on boundaries of surface. Light surface still has some noise.



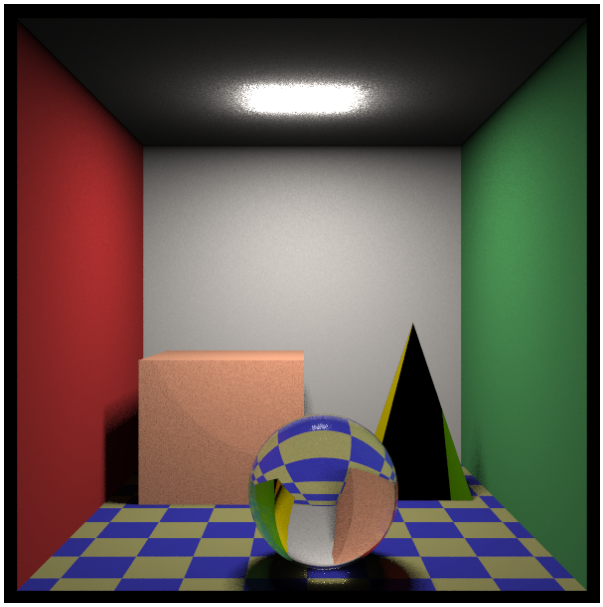
SPP value: 1000
Light surfaces and distribution is much smoother.

Scene with Metallic Pyramid and Transparent Sphere

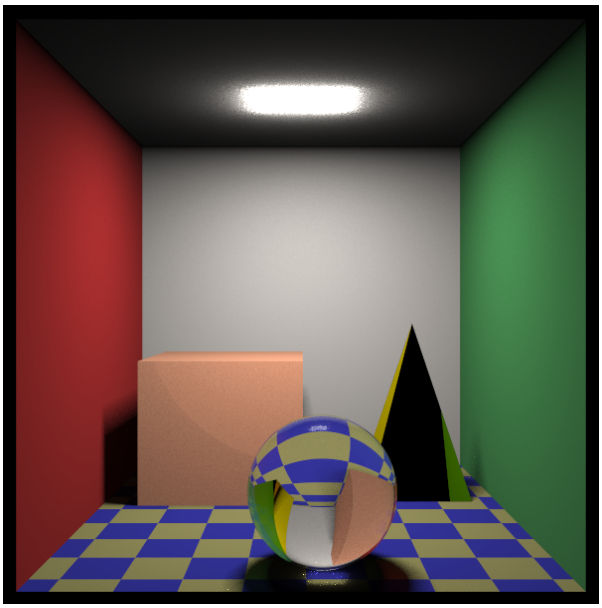
The pyramid is a perfect metallic surface (a mirror) with RGB color value of (255,215, 0) i.e. gold color. Sphere is made of glass (refractive index = 1.5) and we observe reflections of other surfaces on it due to TIR. The color outside the room is black, that's why we see black on front surface of the pyramid.



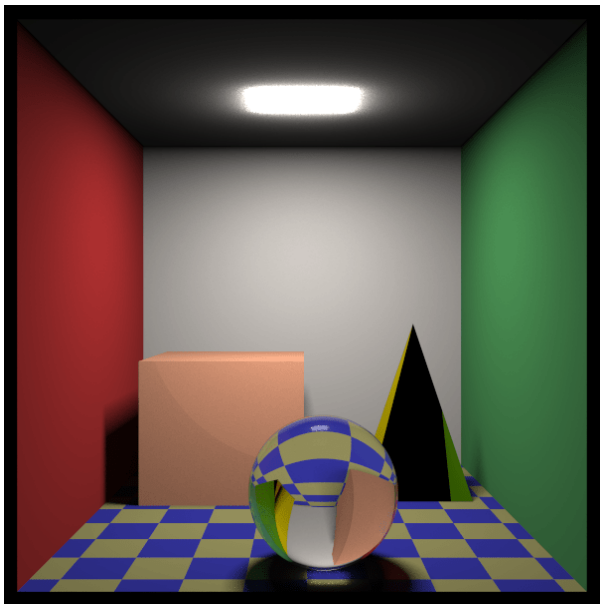
SPP value: 10
Time to render: ~6 seconds
A lot of noise in the image.



SPP value: 50
Time to render: ~30 seconds
A little noise remains on the surfaces.

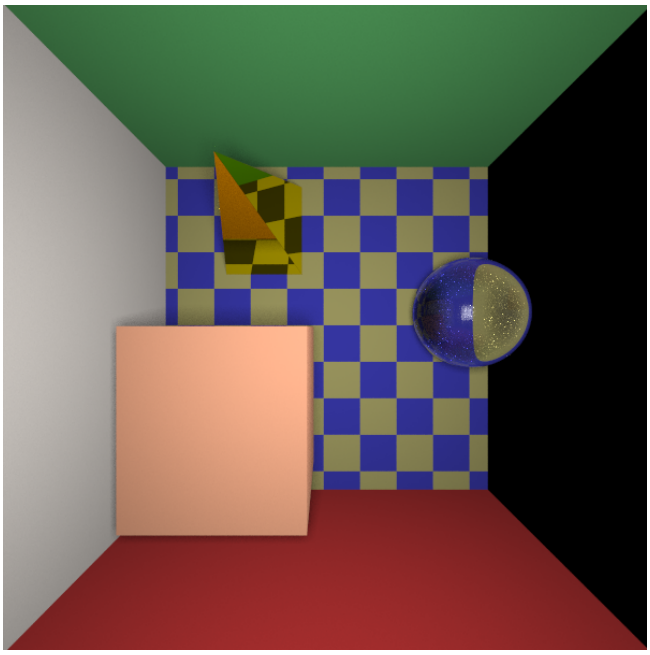


SPP value: 200
Time to render: ~2 minutes
Light and shadow of the surface still have noise.
The white shine on the top of sphere is bit blurry.



SPP value: 1000
Time to render: ~10 minutes
A white shine over the sphere is more clear.
Shadow and lights are much smoother.

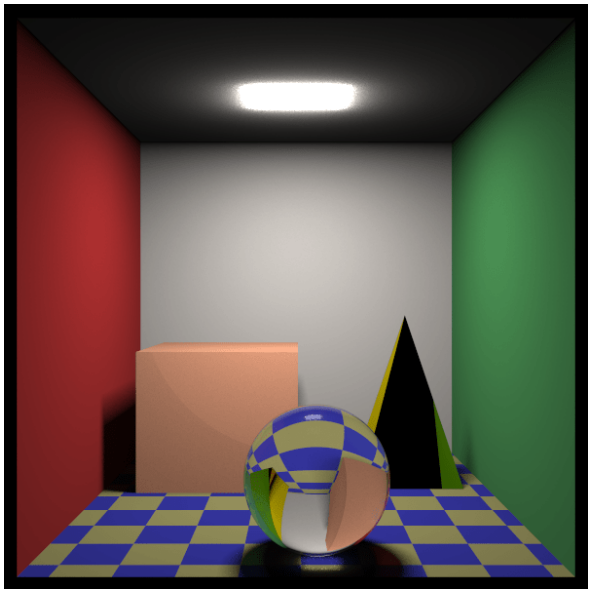
Below is the top view of the scene on how viewpoints affect the render.



BVH timings

Rendered scene

- SPP = 1000
- **Without BVH:** Took around ~12 minutes to render
- **With BVH:** Took around ~10 minutes to render

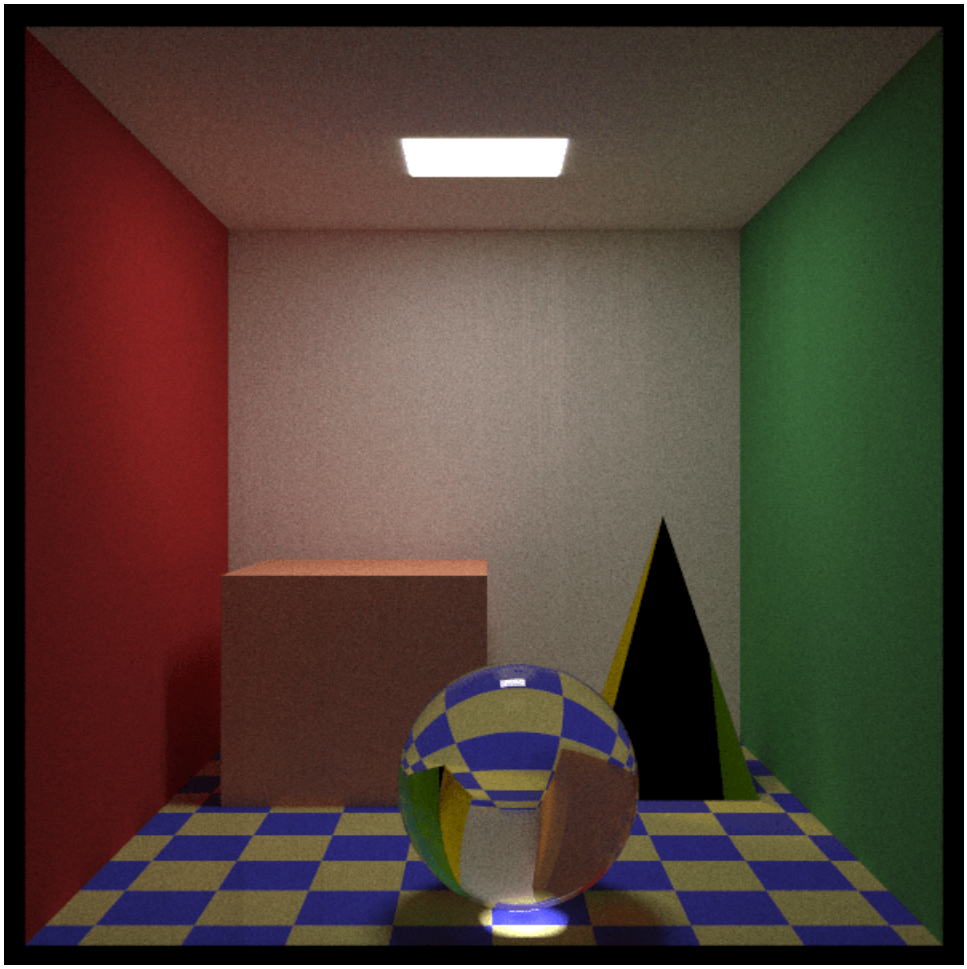


So approximately, BVH is saving about 15-20% of the time to render in this case.
Also, since the Cornell box scene has very few objects, the time saved might be less, but if we try to render scenes with many objects, we might get large savings in rendering time.

A FINAL NOTE

I have chosen to sample light non-uniformly among all direction using the inverse square law. This is done by sending more rays in our desired direction and give less weightage to unimportant rays. This is done by defining a probability density function for light distribution.
As a consequence of this method, shadows have become more prominent and scattering of light is very less due to which the roof color has darkened. Some pros of this approach include very less noise at low values of SPP and thereby less time to render.

If we ignore the distribution, we would obtain the below image at 5000 SPP value with around 40 minutes to render with BVH. As we can see, here the light is distributed uniformly which doesn't happen in real case. Have added results of this method in results



Hence I opted for the first approach.