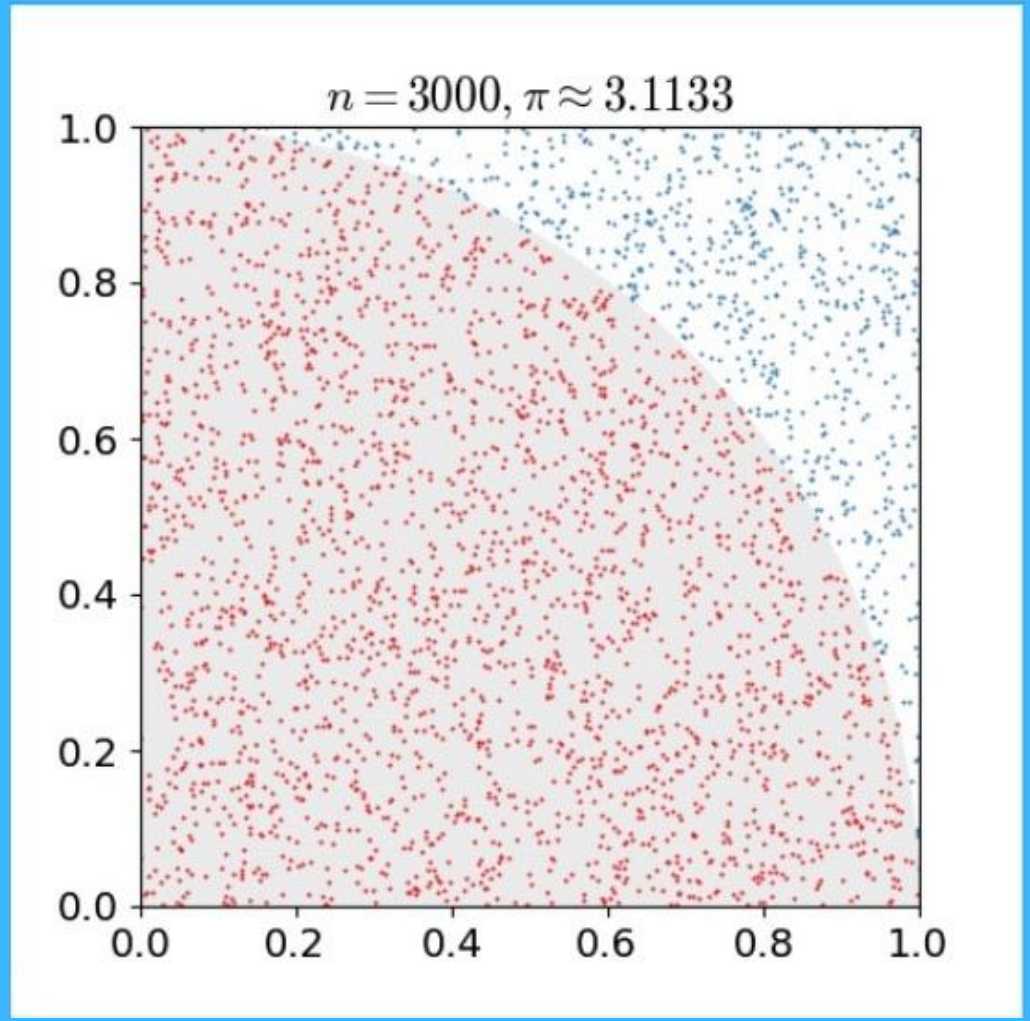

METROPOLIS LIGHT
TRANSPORT
Defenders of Metropolis
Logan Cundiff • Mitchell Joppru • Michael Levecque • Logan Peck • Jonathan Pereyra

Introduction

Monte Carlo Algorithms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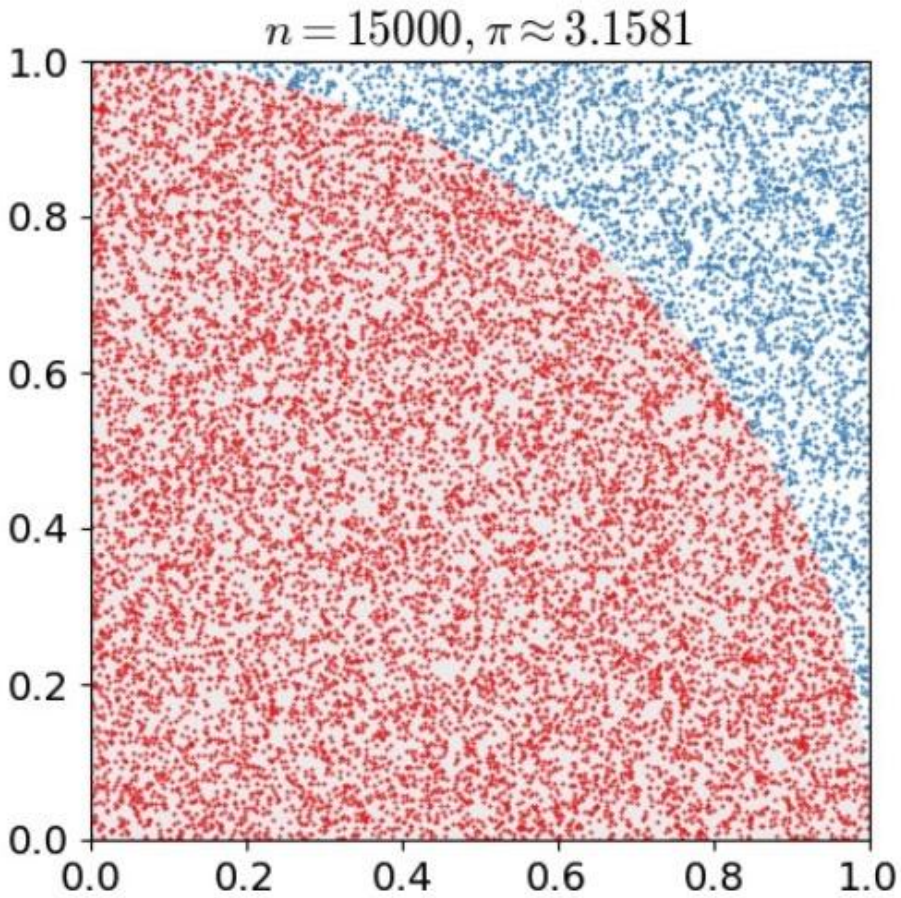
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


$n = 15000, \pi \approx 3.1581$
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0.4
0.2
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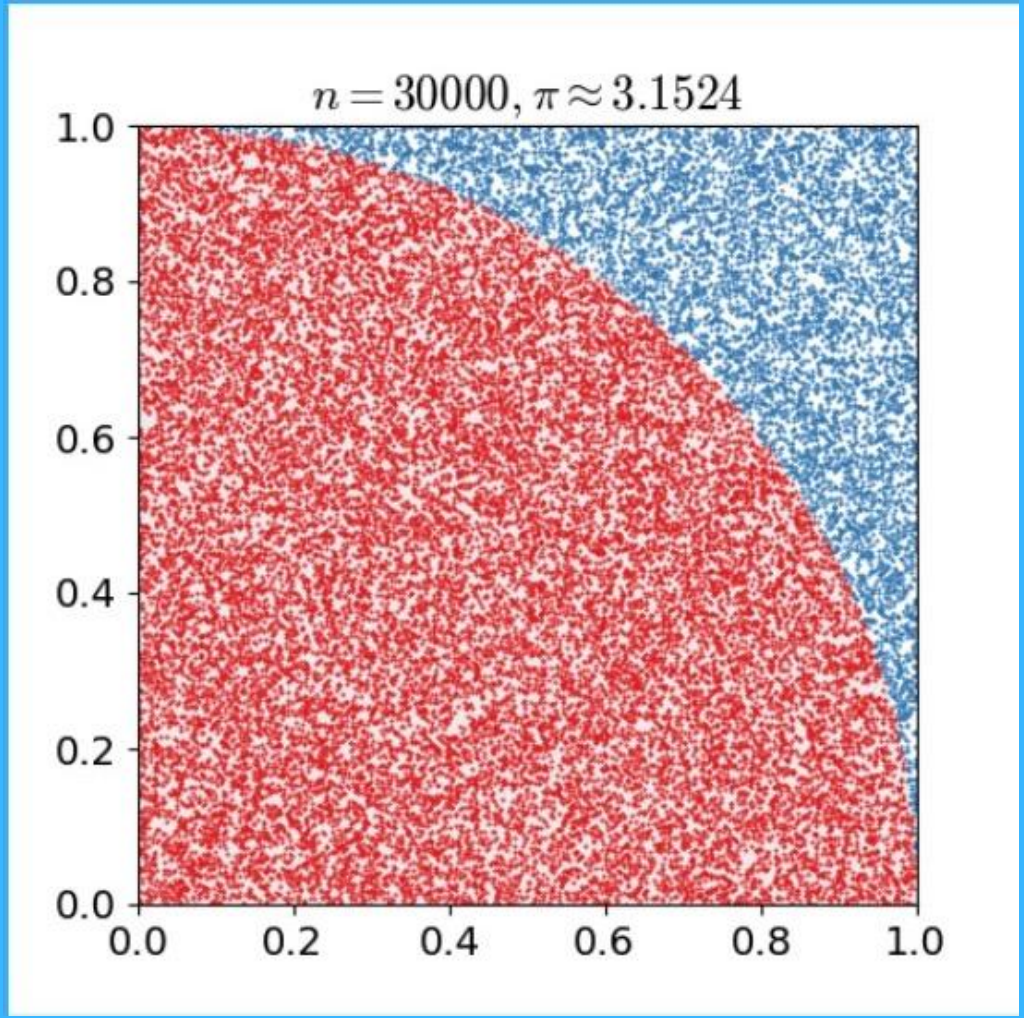
0.4
0.6
0.8
1.0


$n = 30000, \pi \approx 3.1524$
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0.2
0.0
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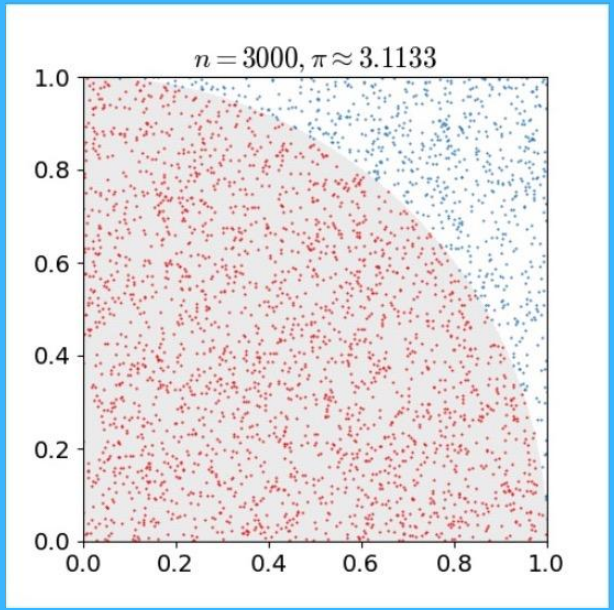
0.2
0.4
0.6
0.8
1.0


$n = 3000, \pi \approx 3.1133$
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0.8
0.6
0.4
0.2
0.0
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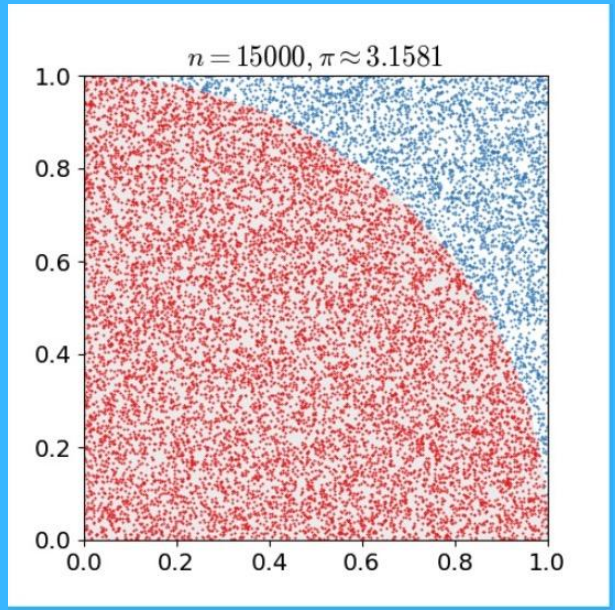
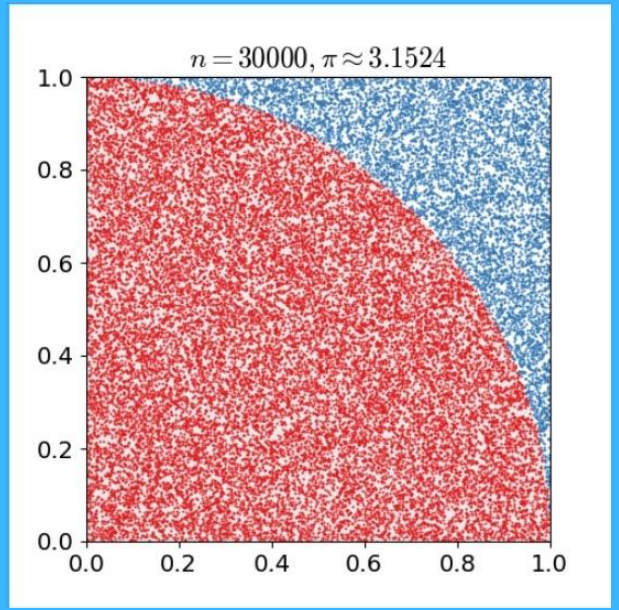
0.2
0.4
0.6
0.8
1.0

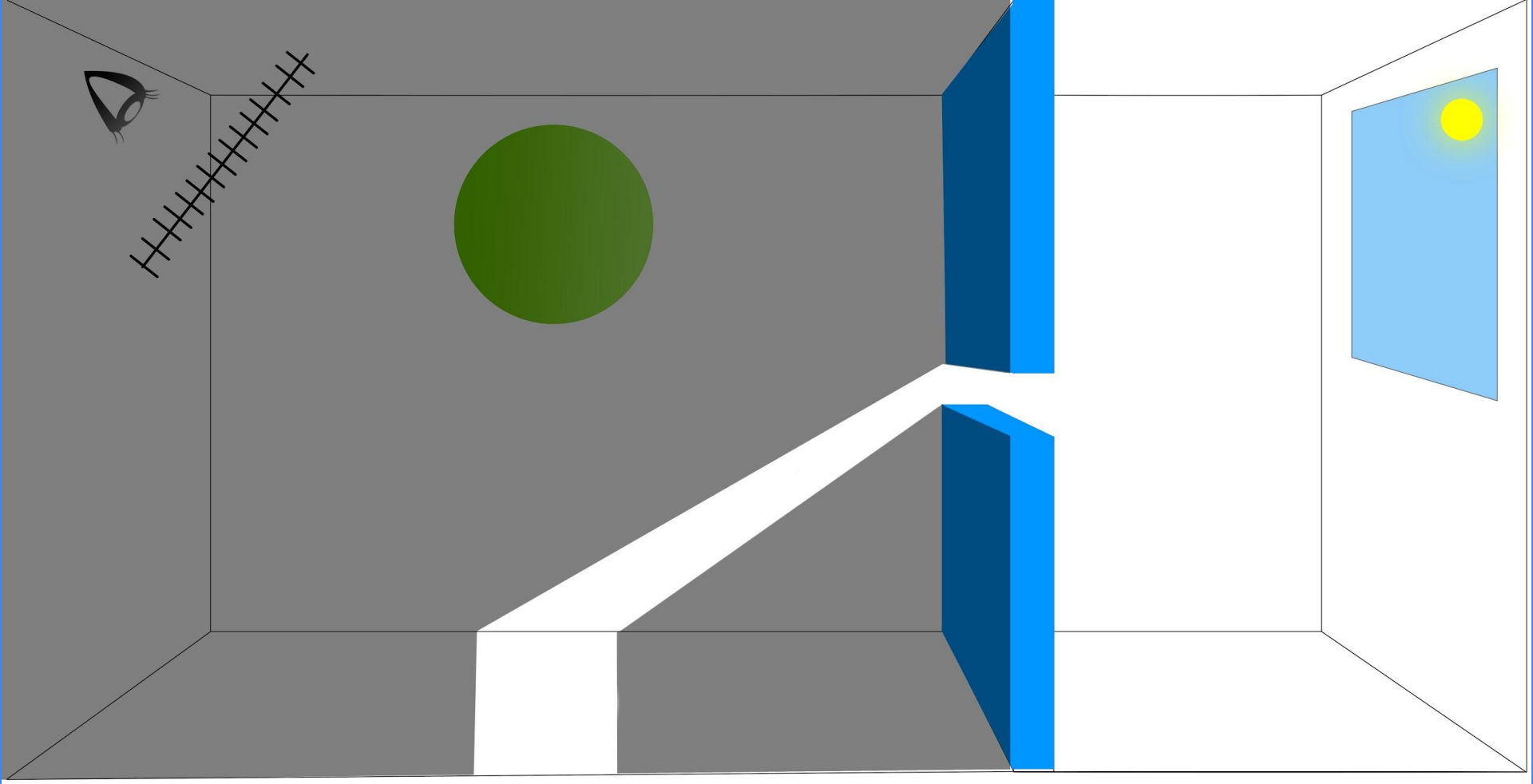

$n = 15000, \pi \approx 3.1581$
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

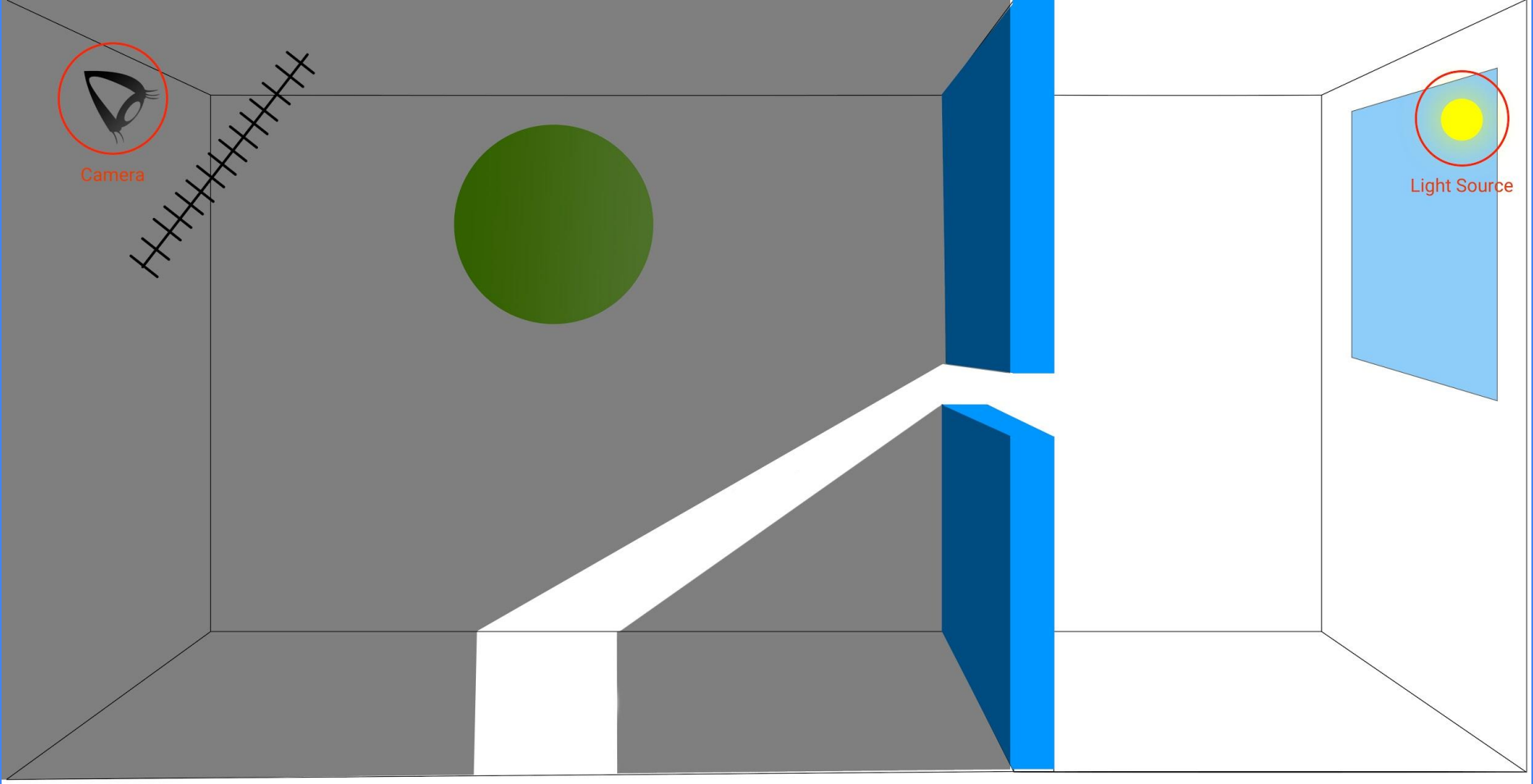

$n = 30000, \pi \approx 3.1524$
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

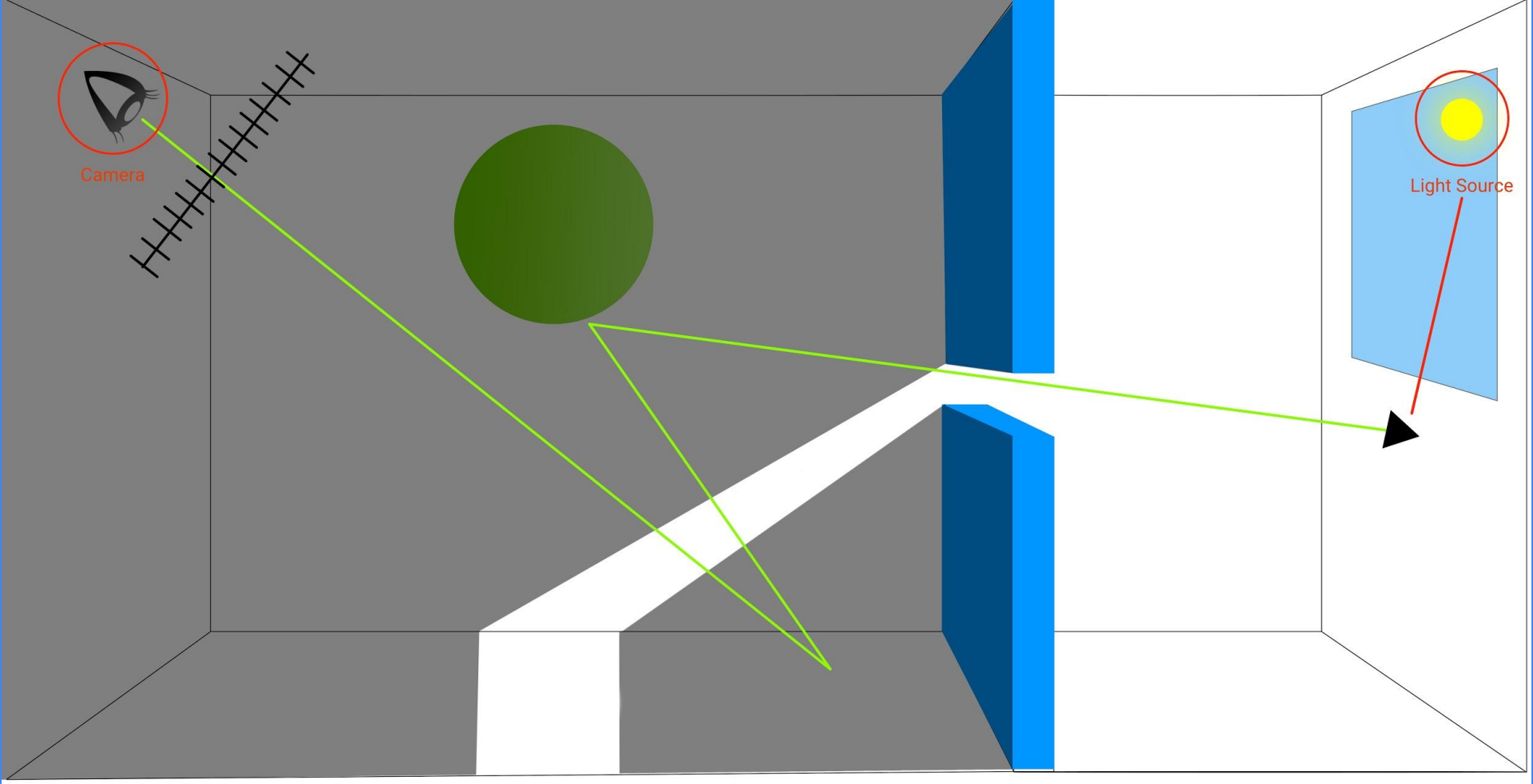
Metropolis Sampling Method

Metropolis Light Transport

Method Overview




Camera
Light Source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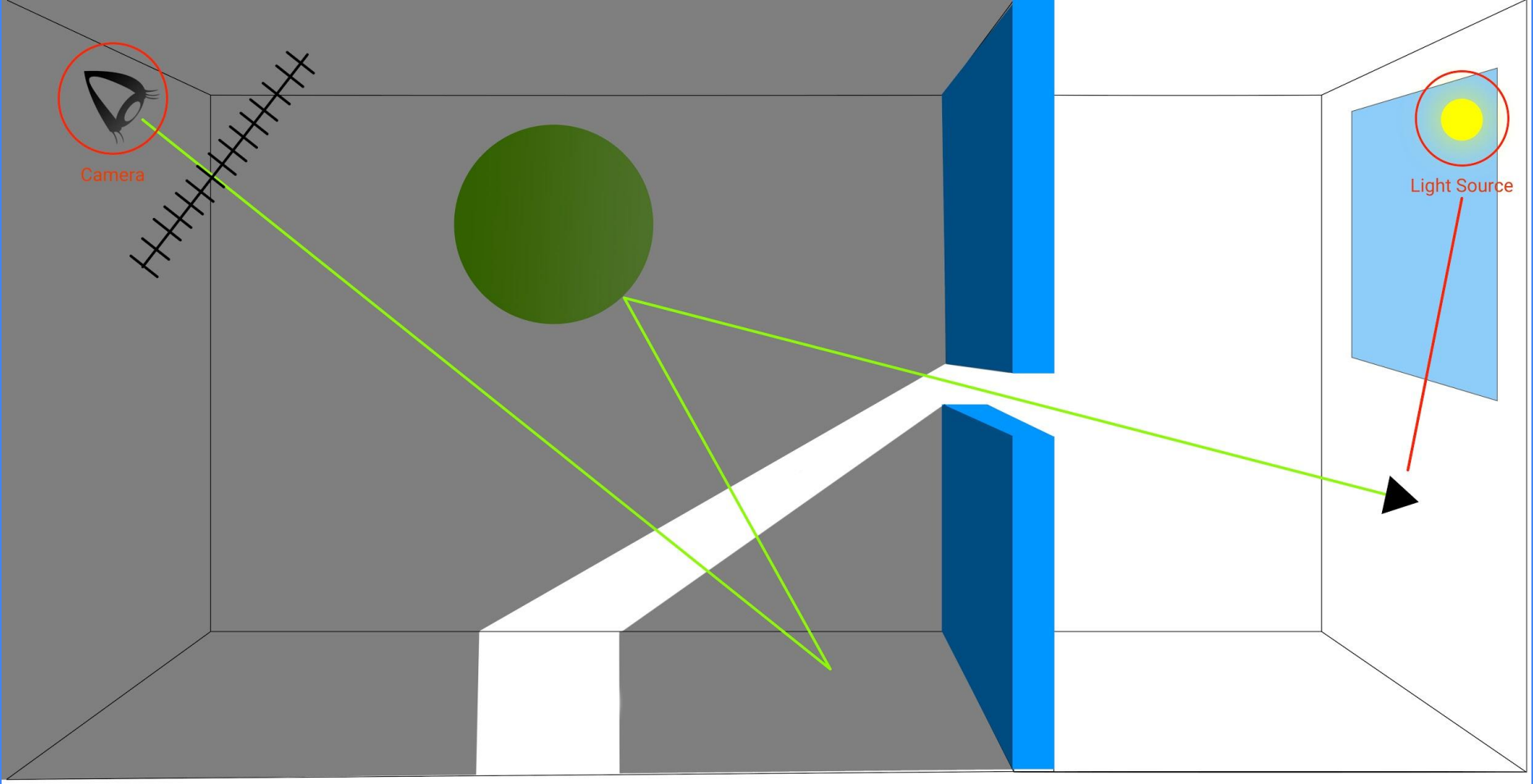
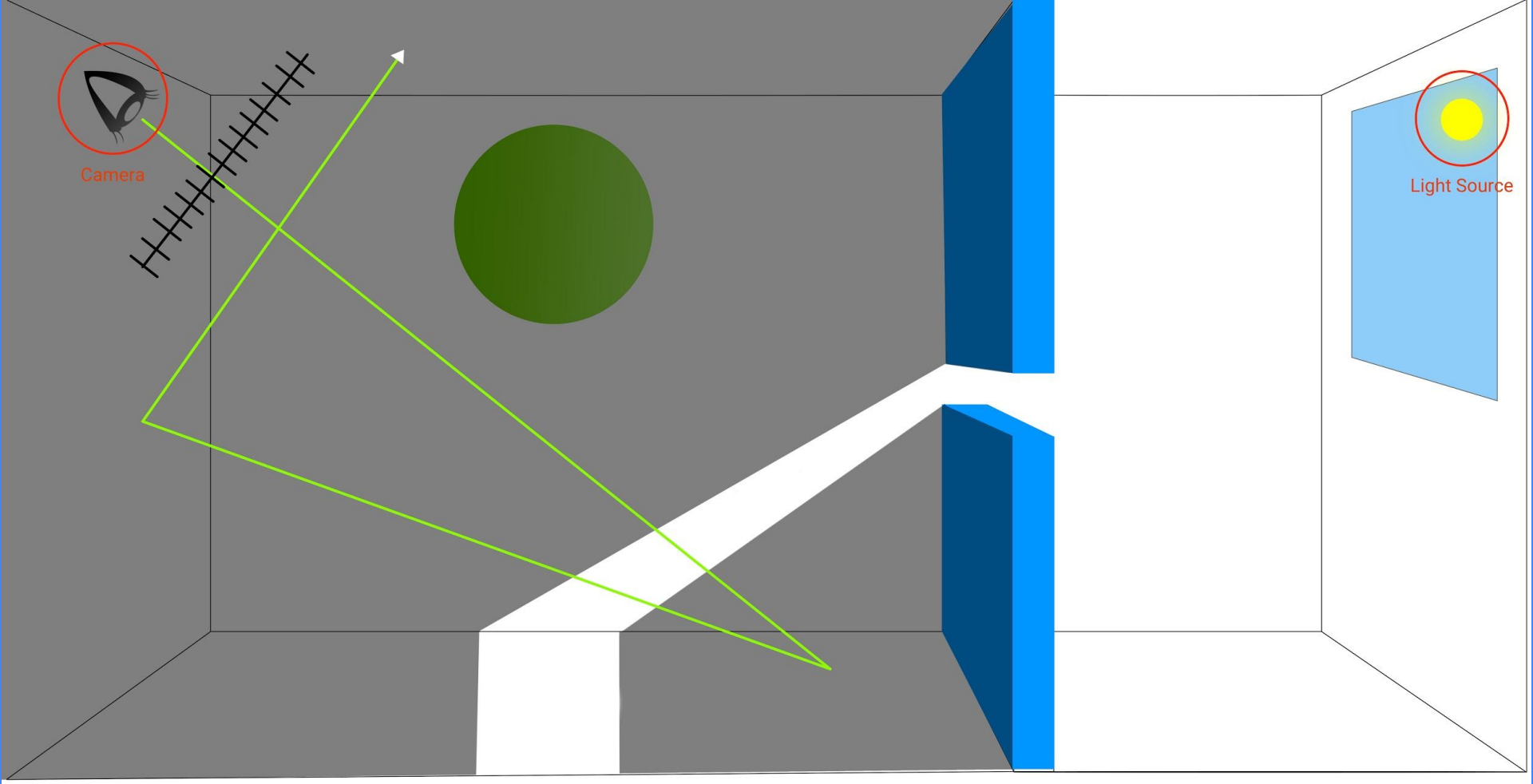
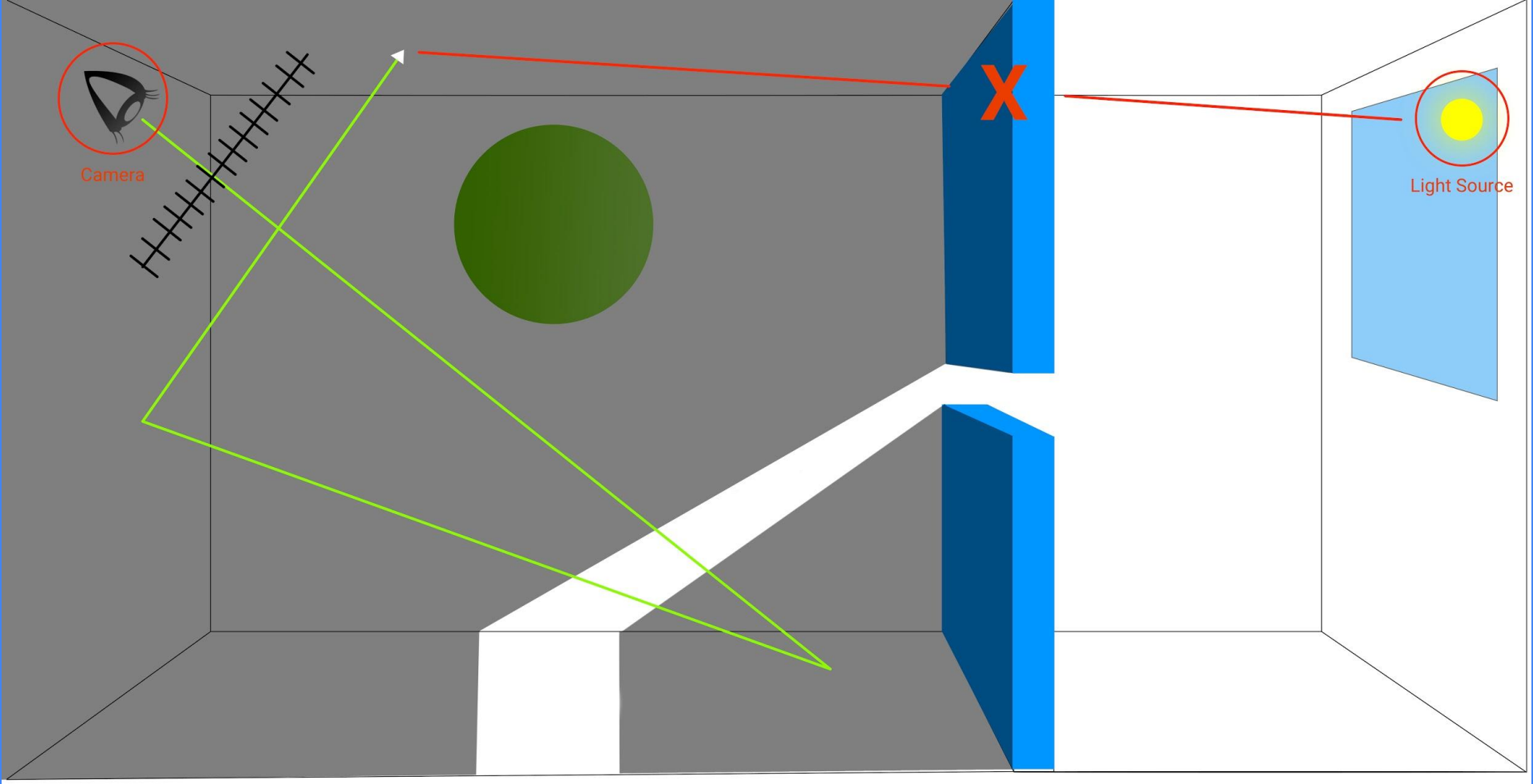

Camera
Light Source


Camera
Light Source


Camera
X
Light Source

Algorithm

$\bar{x} \leftarrow$ InitialPath()
image $\leftarrow$ { array of zeros }
for $i \leftarrow 1$ **to** N
    $\bar{y} \leftarrow$ Mutate($\bar{x}$)
    $a \leftarrow$ AcceptProb($\bar{y} \mid \bar{x}$)
    if Random() < a
        then $\bar{x} \leftarrow \bar{y}$
    RecordSample(*image* , $\bar{x}$)
return *image*

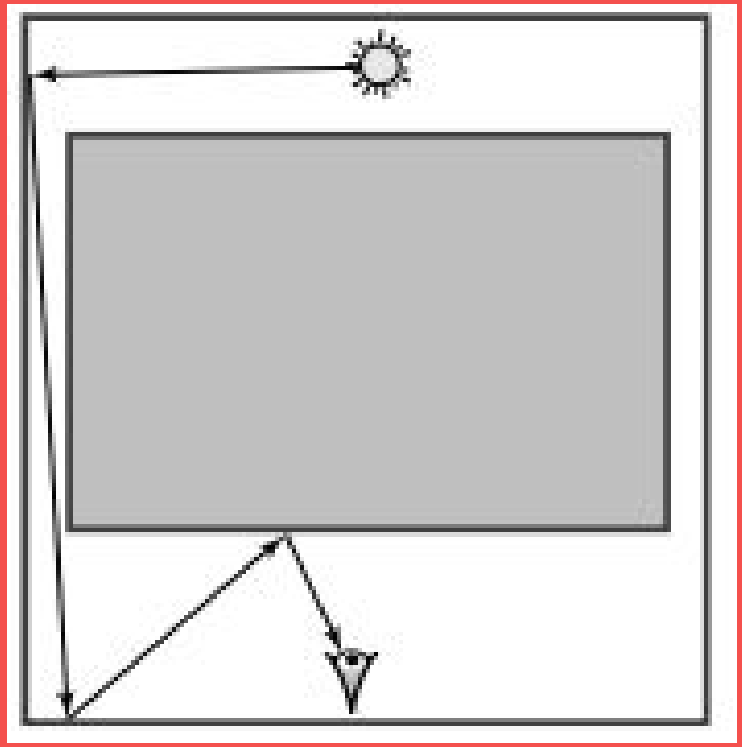
Initialization Phase

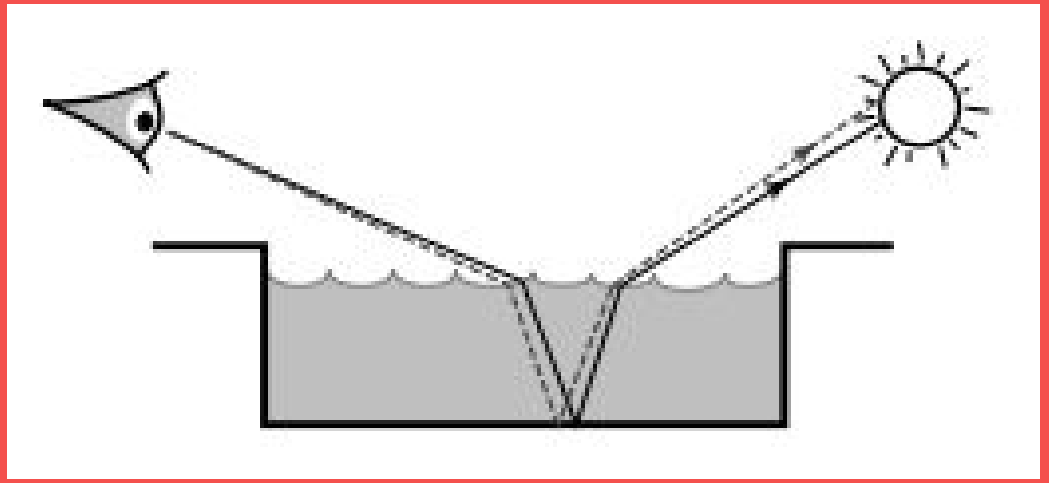
Spectral Sampling

Algorithm:
With Color

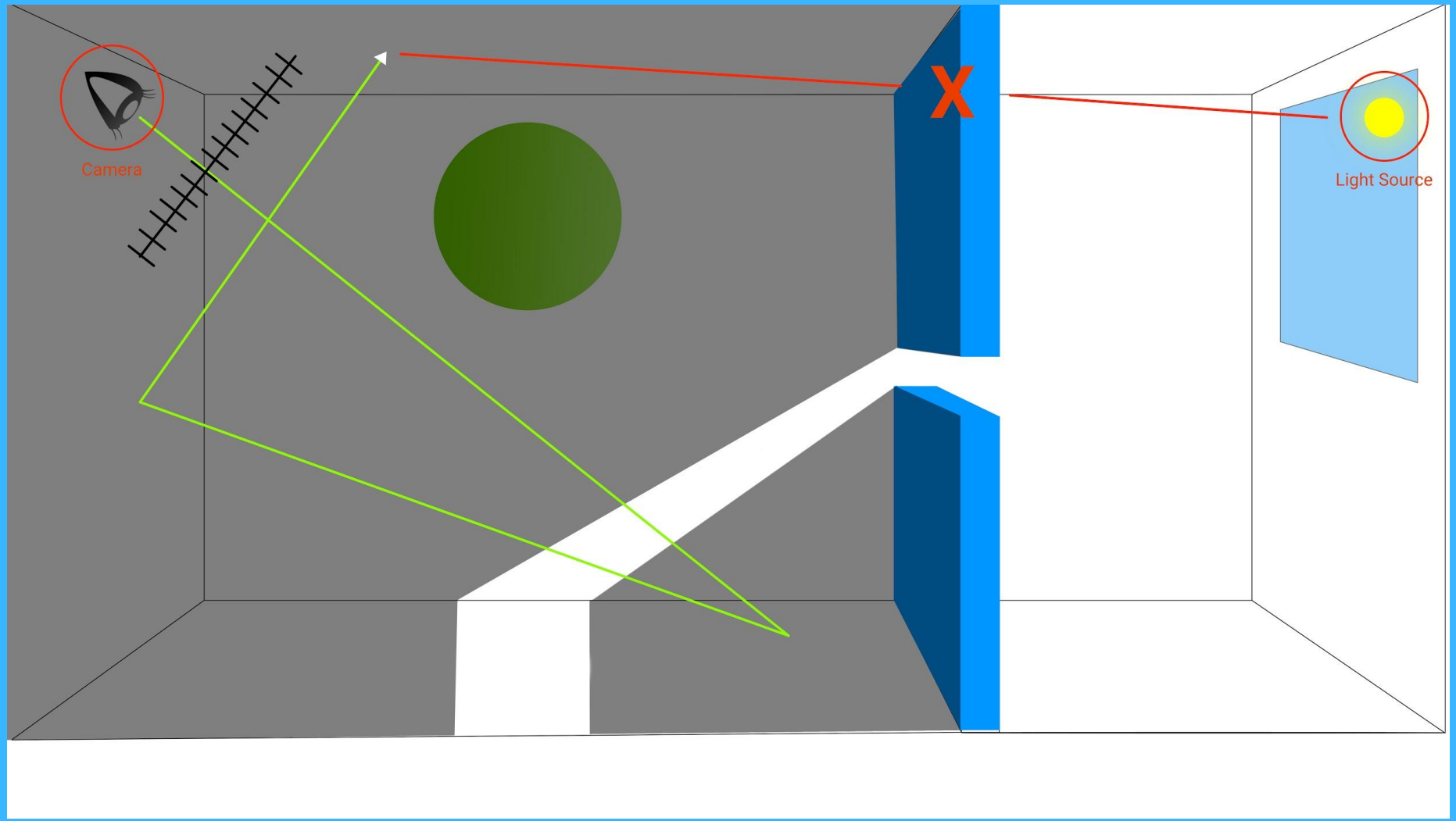
```
x̄ ← InitialPath()
image ← { array of zeros }
for i ← 1 to N
    ȳ ← Mutate( x̄ )
    xColor = color( x̄ )
    yColor = color( ȳ )
    xLum = luminance( xColor )
    yLum = luminance( yColor )
    a ← AcceptProb( yLum | xLum )
    if Random() < a
        x̄ ← ȳ
        xColor = yColor
    RecordSample( image , x̄, xColor )
return image
```

The Metropolis Phase: Mutation Strategies

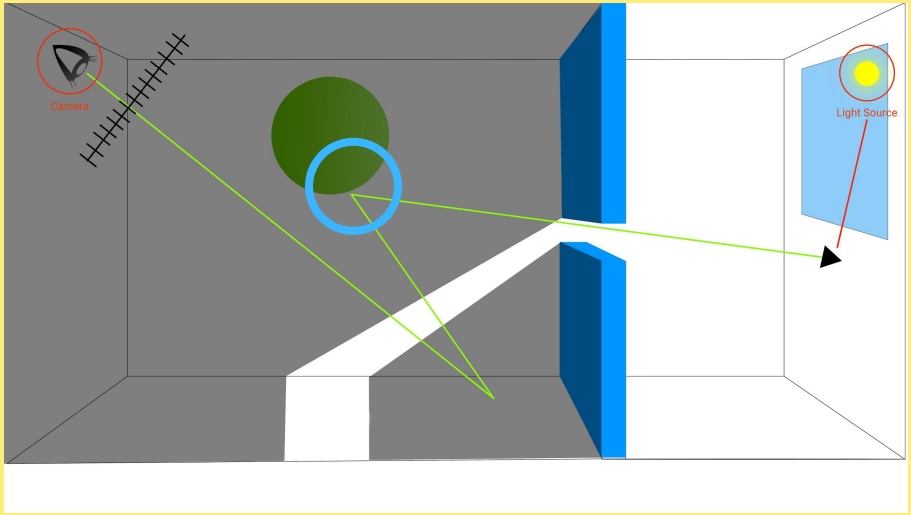


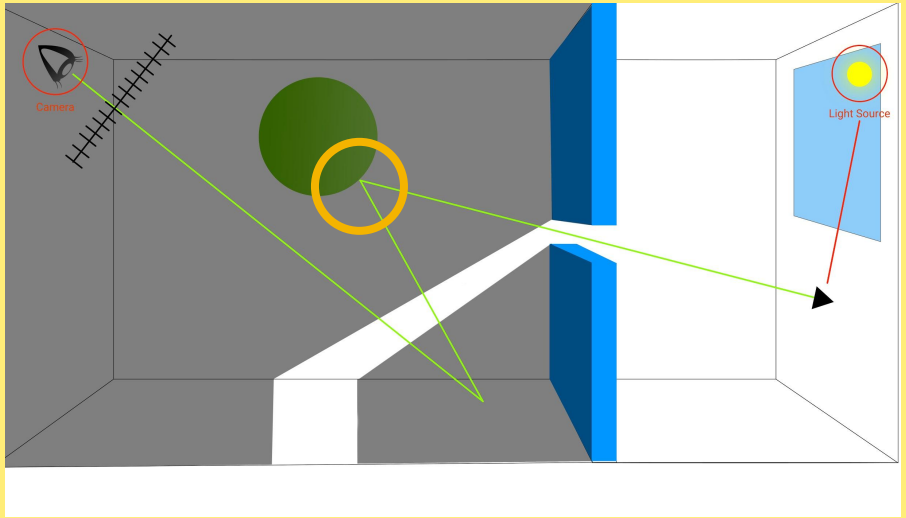


Acceptance Probability

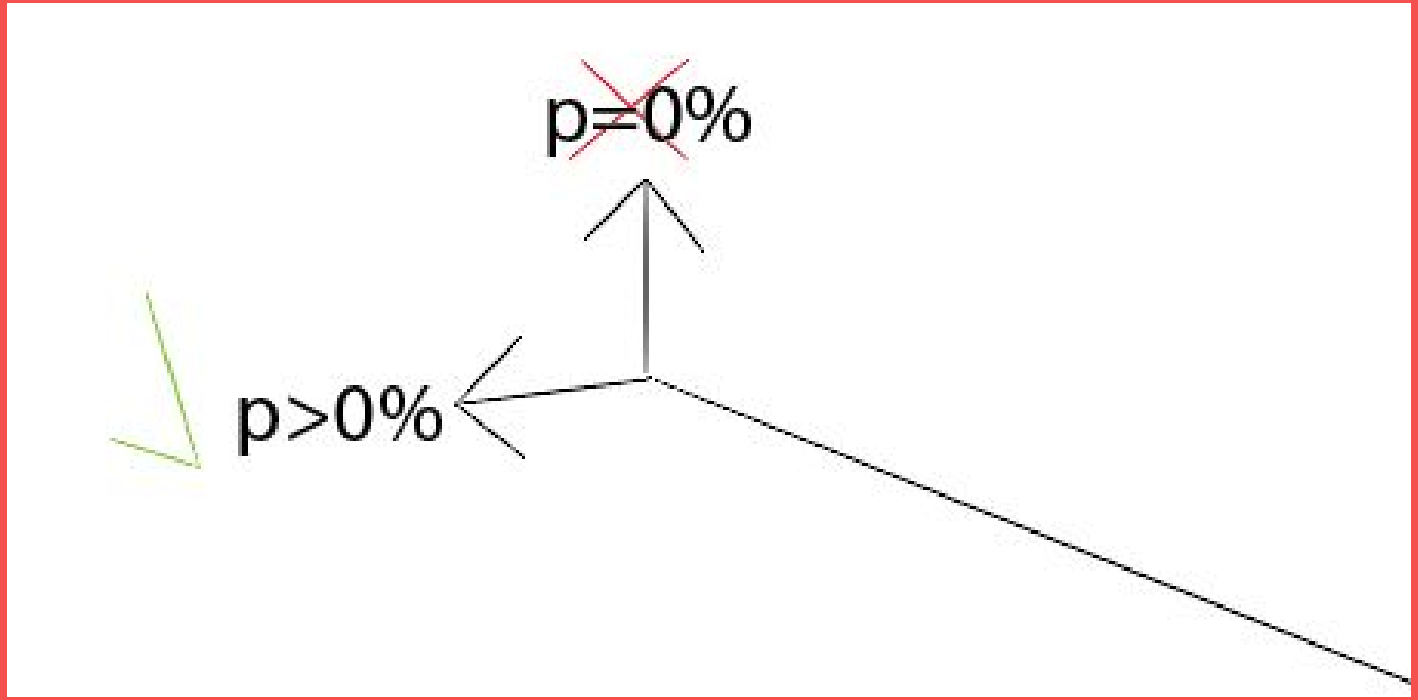

Camera
X
Light Source

Path Change


Camera
Light Source

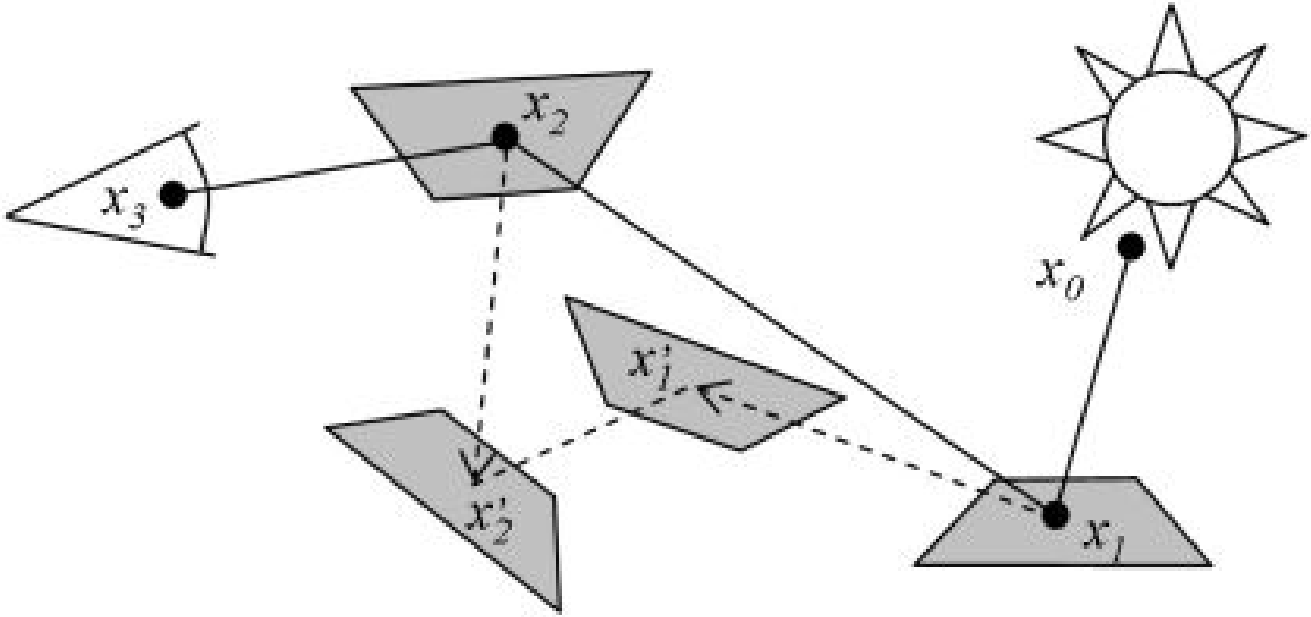

Camera
Light Source

Ergodicity

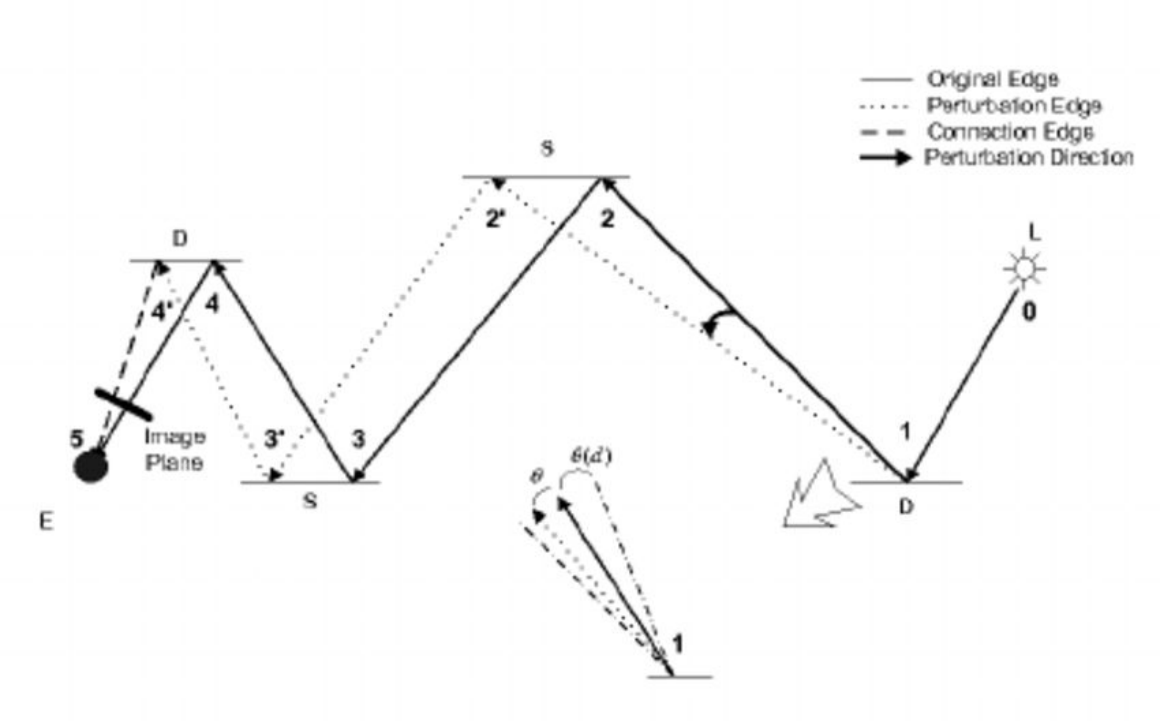

p=0%
p>0%

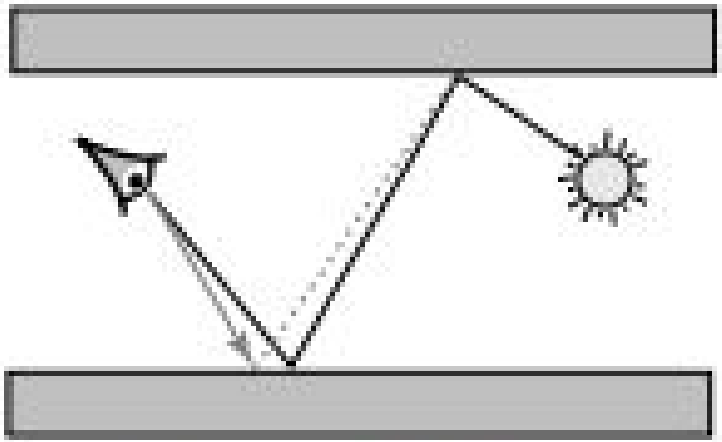
Stratification

Bidirectional Mutations

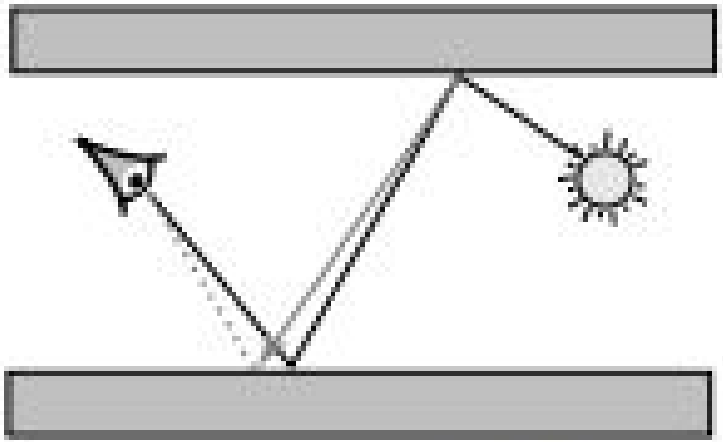

x_3
x_2
x_0
x_1'
x_2'
x_1

Perturbations


Original Edge
Perturbation Edge
Connection Edge
Perturbation Direction
S
D
L
2'
2
4'
4
0
5
Image
Plane
3'
3
1
E
S
D
θ
θ(d)
1

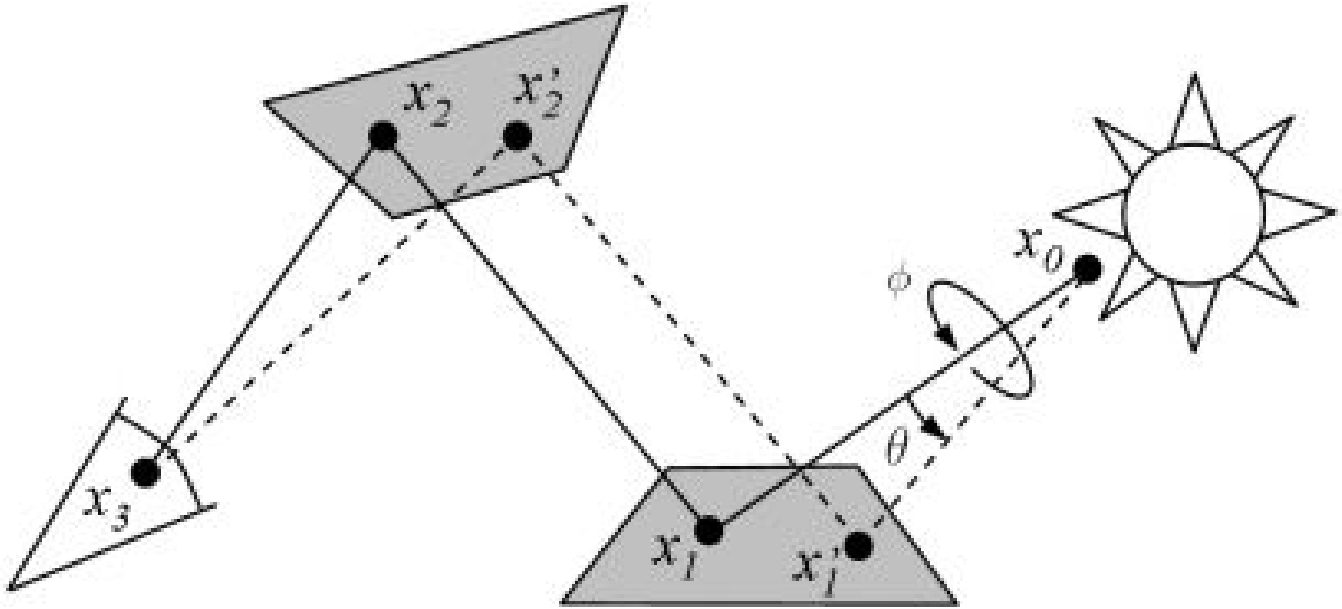


Lens perturbation



Caustic perturbation

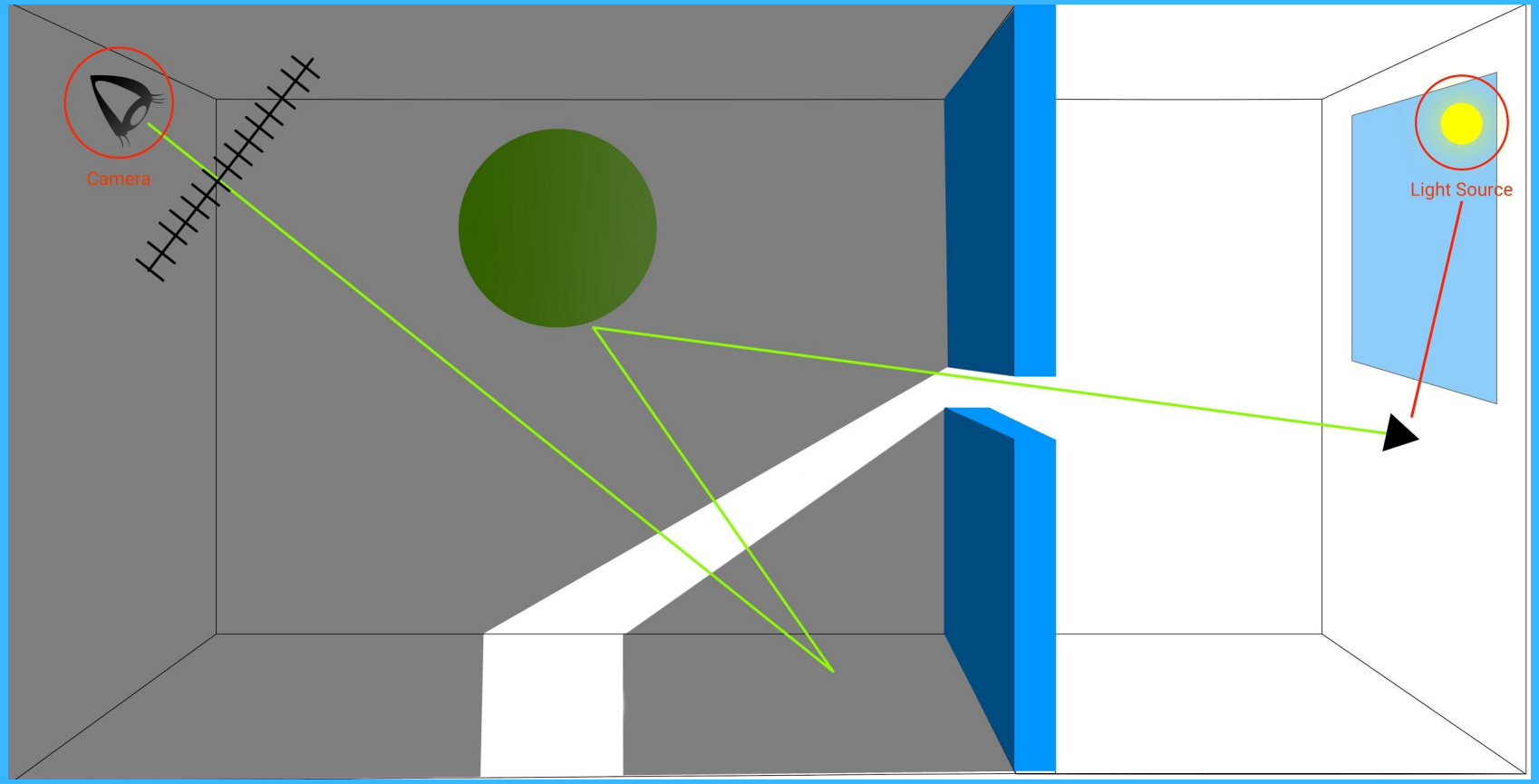
Lens Subpath Mutations


x_2
x_2'
x_0
ϕ
θ
x_3
x_1
x_1'

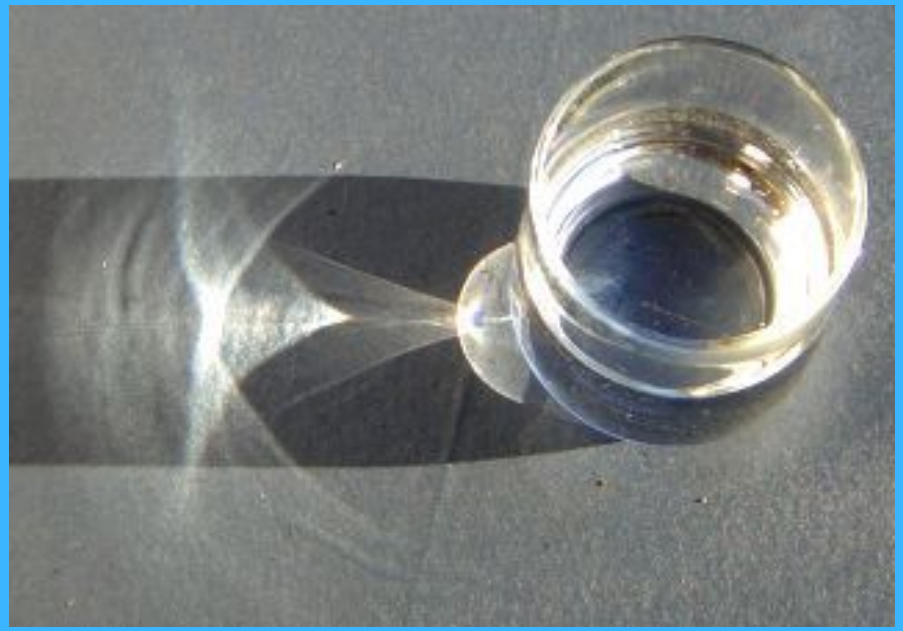
Advantages and Disadvantages of MLT

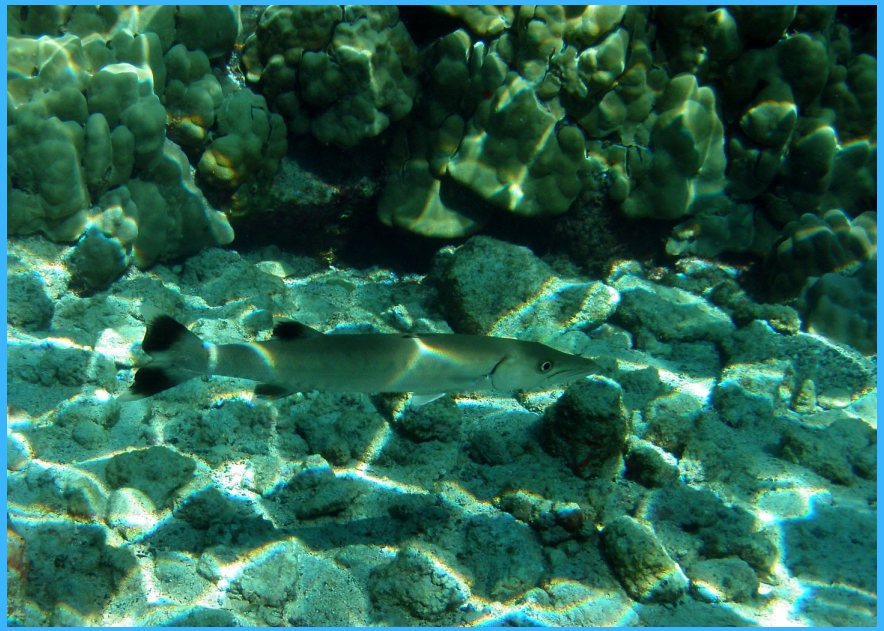
MLT Use Cases

Indirect Lighting



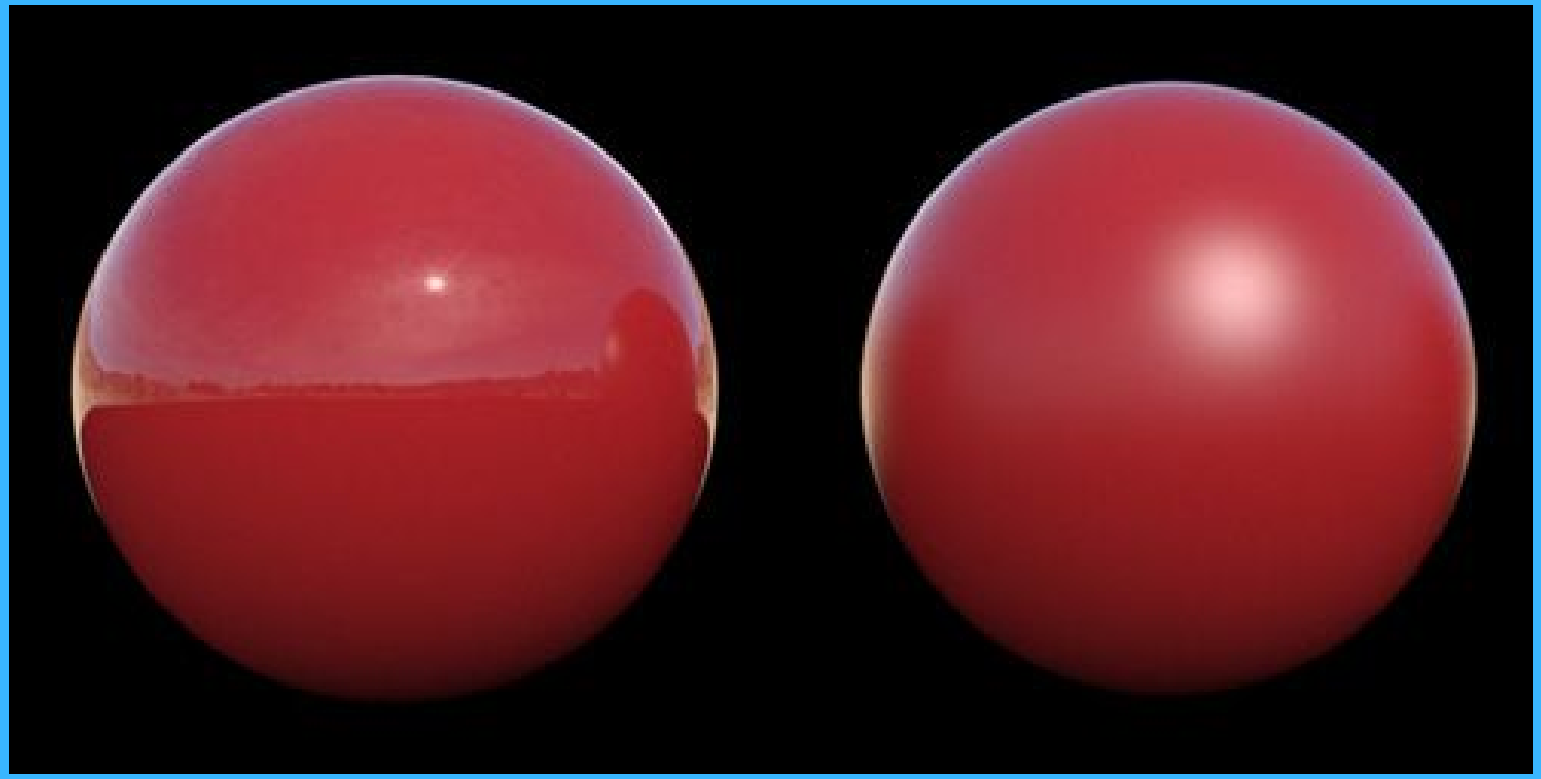
Caustics





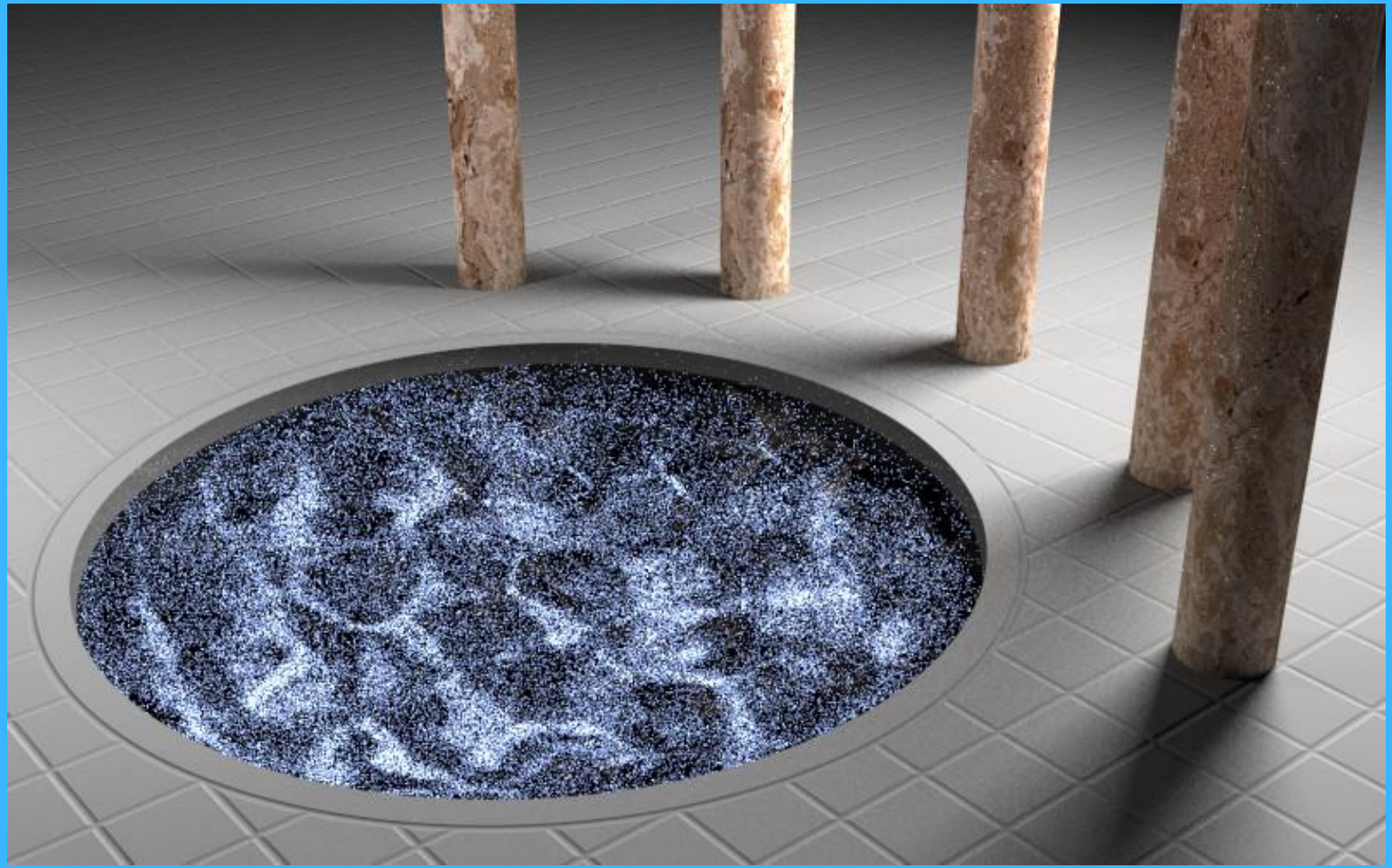
https://en.wikipedia.org/wiki/Caustic_(optics)

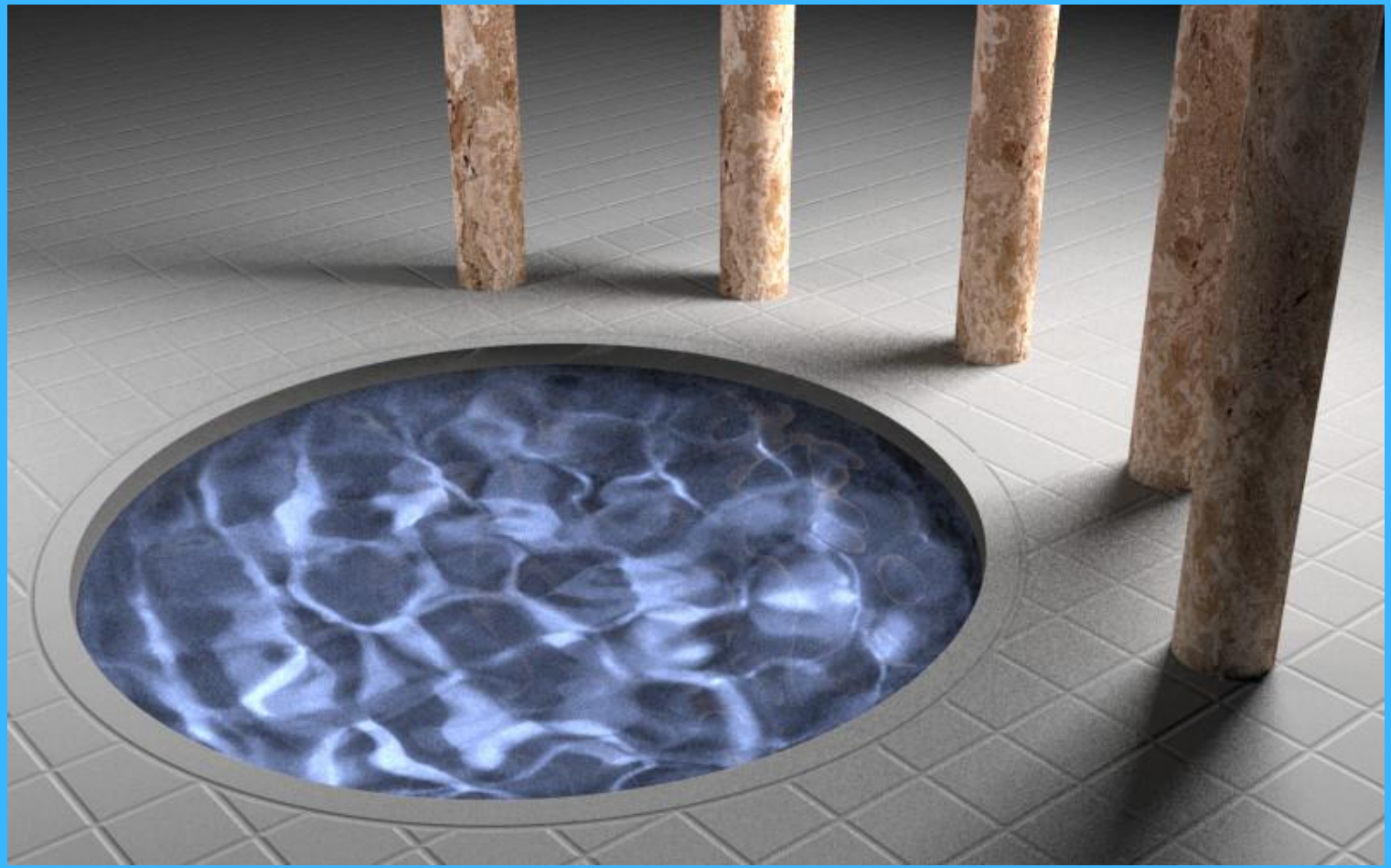
Non-Diffuse Surfaces



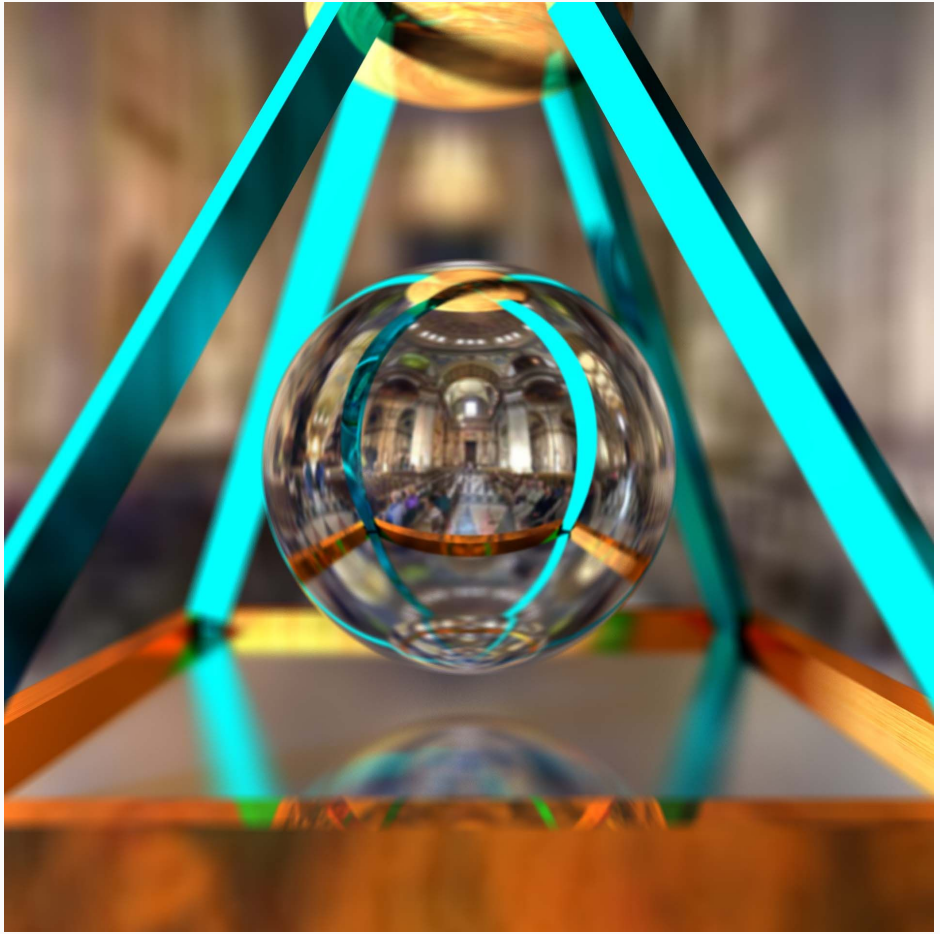
http://www.neilblevins.com/cg_education/reflection_highlight/reflection_highlight.htm

Method Comparisons





Compared to Ray Tracing



https://courses.cs.washington.edu/courses/cse557/08wi/projects/trace/

Compared to Radiosity

http://csis.pace.edu/~marchese/CG/Lect1/Lecture_1.html

Conclusion

Questions?