CODE3

SoSe 2026

Prof. Dr.-Ing. Uwe Hahne

Lighting and shadows

Lighting and shaows

- General ideas (plenoptic function)
- Ray Tracing, Ray Casting, Ray …
- Shadows
- Global illumination
- Radiosity

Sources

The Graphics Codex:
http://graphicscodex.com/

https://learnopengl.com/Advanced-Lighting/Shadows/Shadow-Mapping

https://docs.unrealengine.com/4.27/en-US/RenderingAndGraphics/RayTracing/

Slides from Marc Alexa, TU Berlin

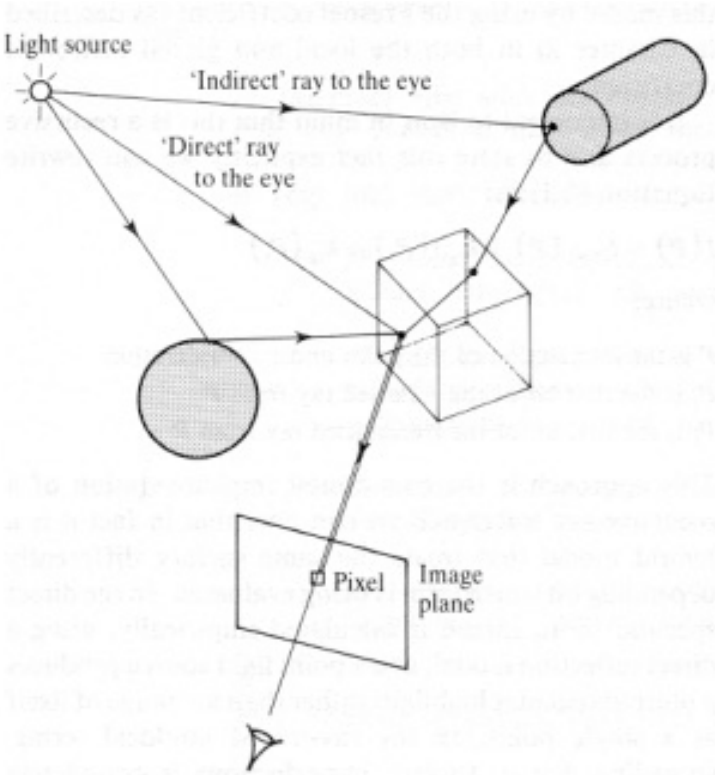
Raytracing (History)

Albrecht Dürer „der zeichner des legenden weibes“, 1538

Depicting of Alberti (1404 – 1472)

(Recursive) Raytracing

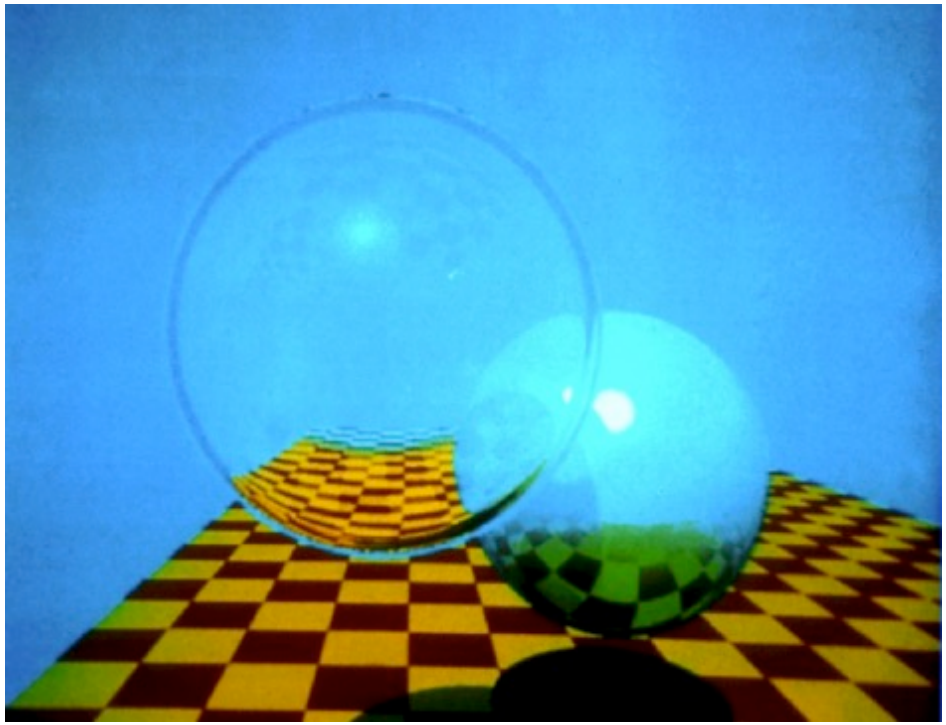
- The basic idea is to trace light rays as they travel from the source to the eye.
- For simplicity, conventional ray tracing only tracks rays that are perfectly reflected and perfectly refracted.
- This tracing is performed recursively, but must be terminated when surfaces reflect light back and forth indefinitely.



(Rekursives) Raytracing

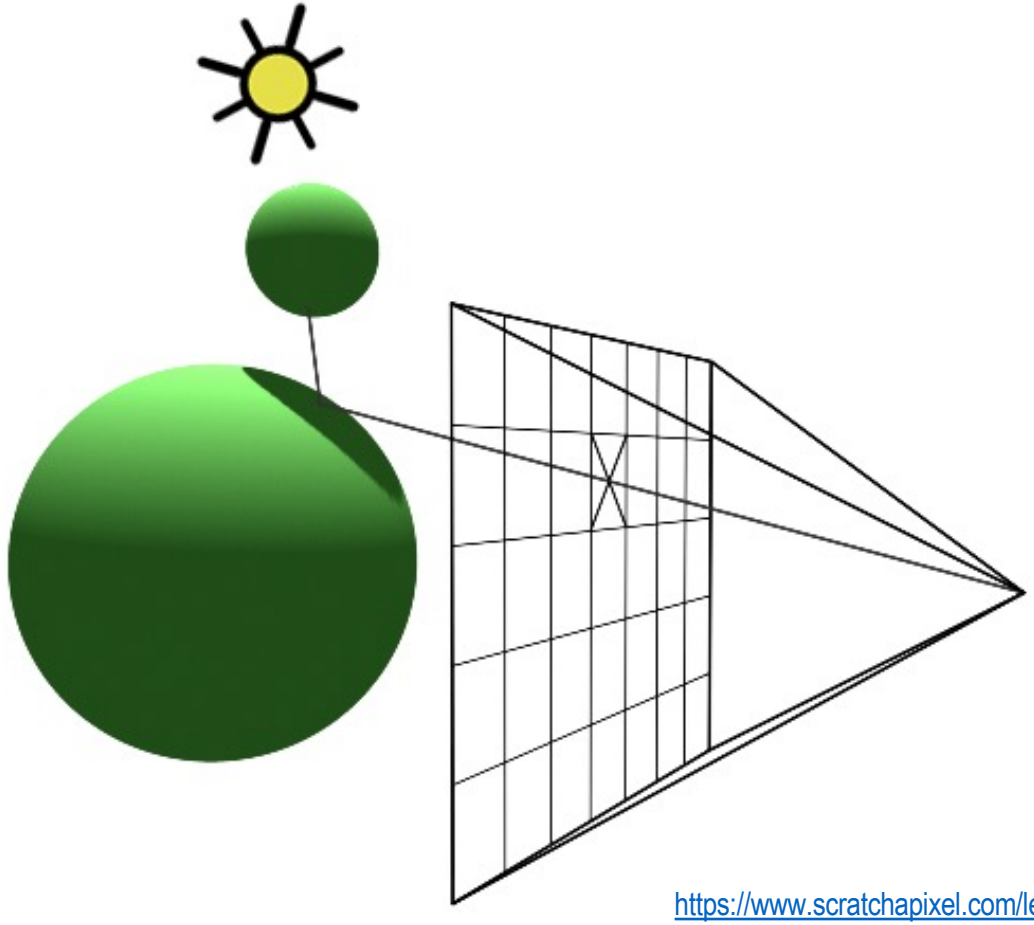
First implementation: Whitted 1979

Ray tracing simulates the process of light propagation and operates according to the laws of ideal reflection and refraction.



Shadows

Shadows are simple in ray-tracing.

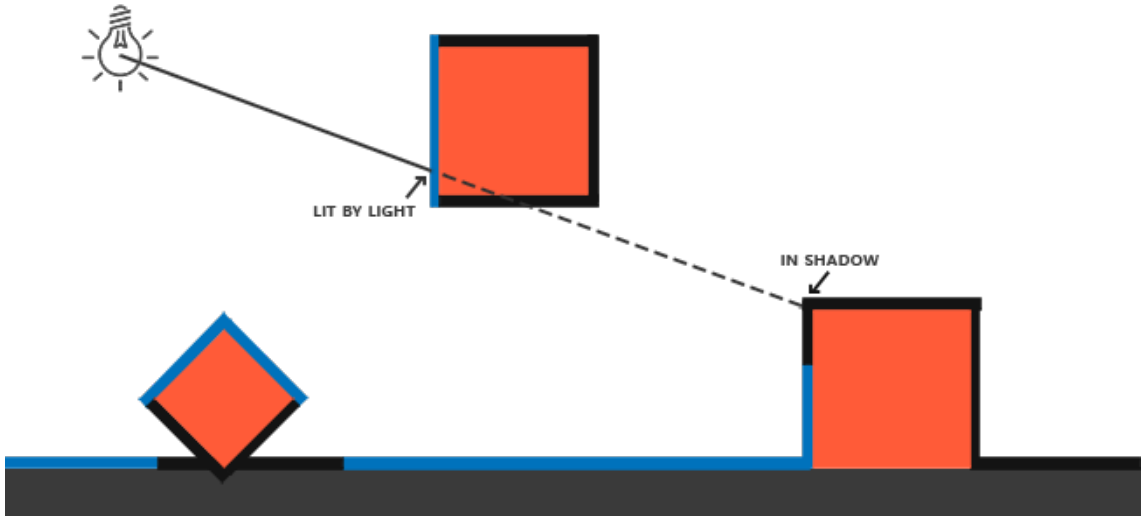


https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-ray-tracing/implementing-the-raytracing-algorithm

Shadow Mapping

The idea is quite simple: we render the scene from the light's point of view, and everything we see from the light's perspective is illuminated.

Everything we cannot see must be in shadow.

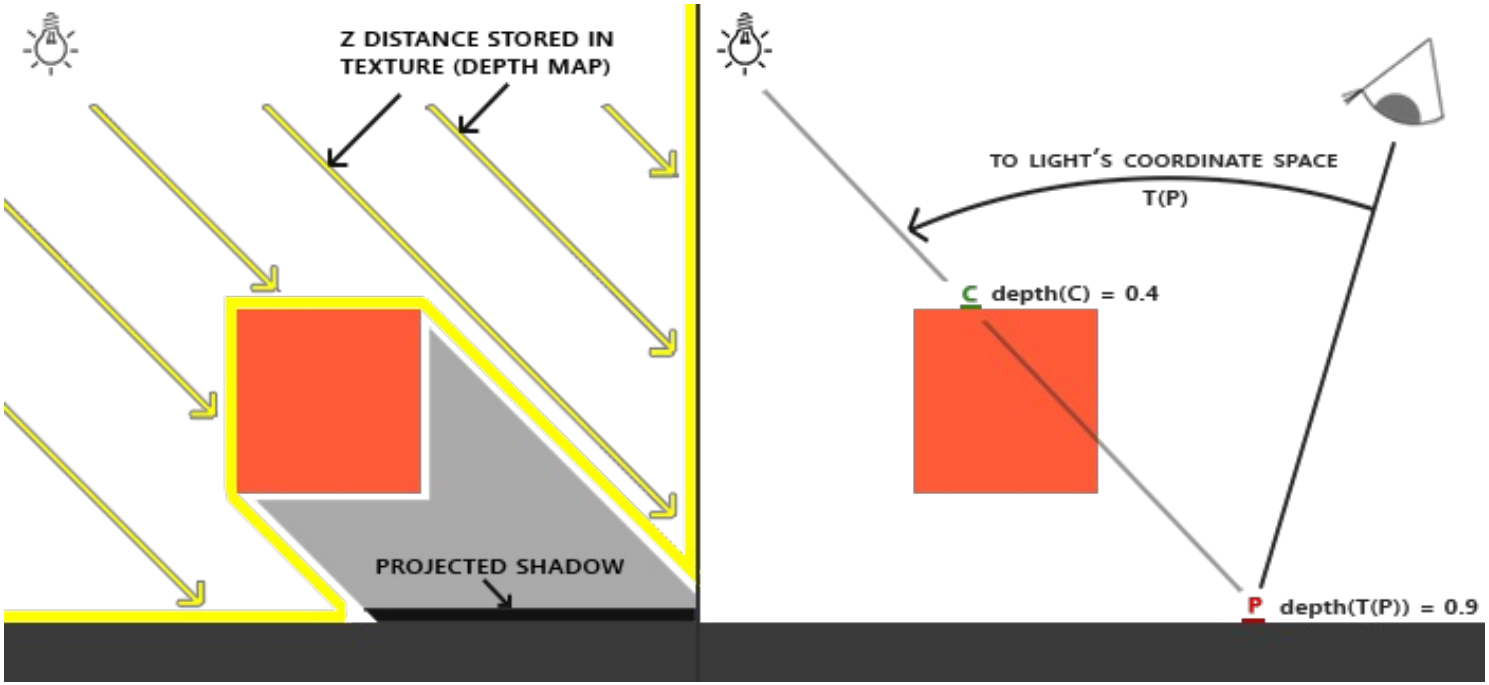


Imagine a section of the floor with a large box between it and a light source. Since the light source sees this box and not the section of the floor when it looks in that direction, that particular section of the floor should be in shadow.

Shadow Mapping

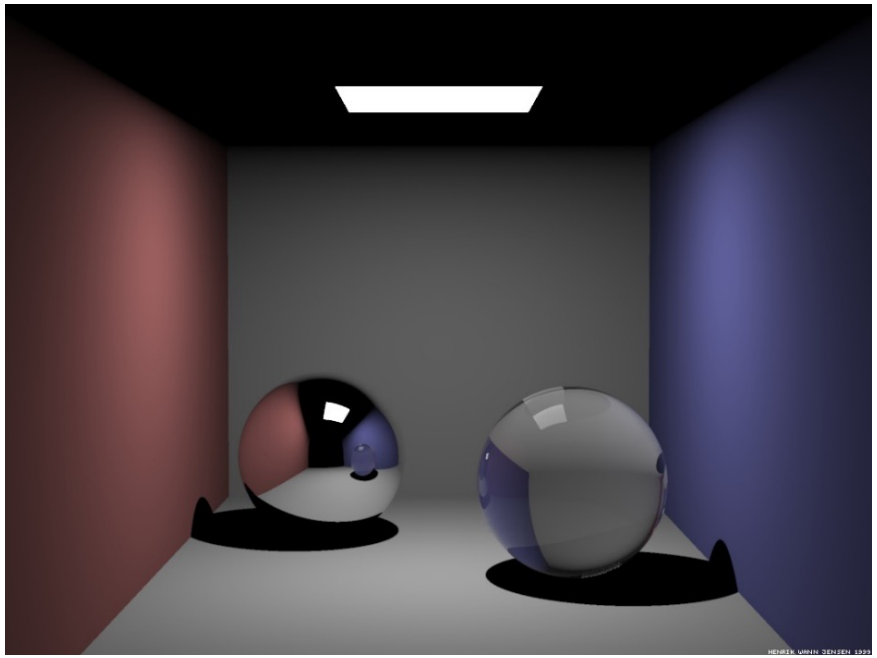
The scene is rendered from the direction of the light sources, the transformation is recorded, and the depth values (z-buffer) are stored in a texture (shadow map).

When rendering from the camera's perspective, this transformation is applied to the position coordinates and the z-value is compared.

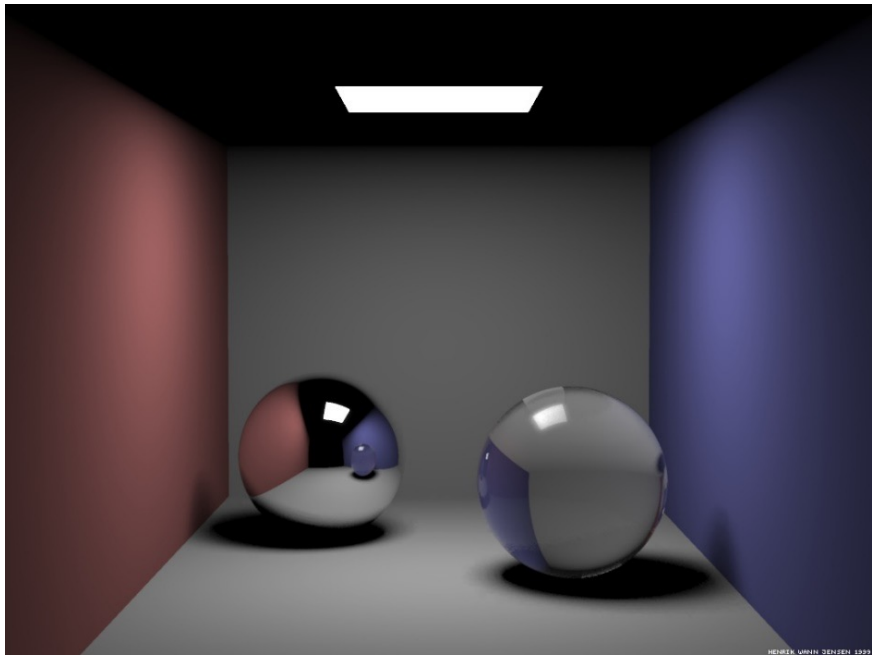


Diffuse Raytracing

Diffuse ray tracing (also known as stochastic or distributed ray tracing) does not treat light sources solely as point light sources and therefore generates multiple random rays.



Recursive Raytracing



Diffuse Raytracing

Images from Henrik Wann Jensen: http://graphics.stanford.edu/~henrik/images/cbox.html

Ray tracing (real-time)

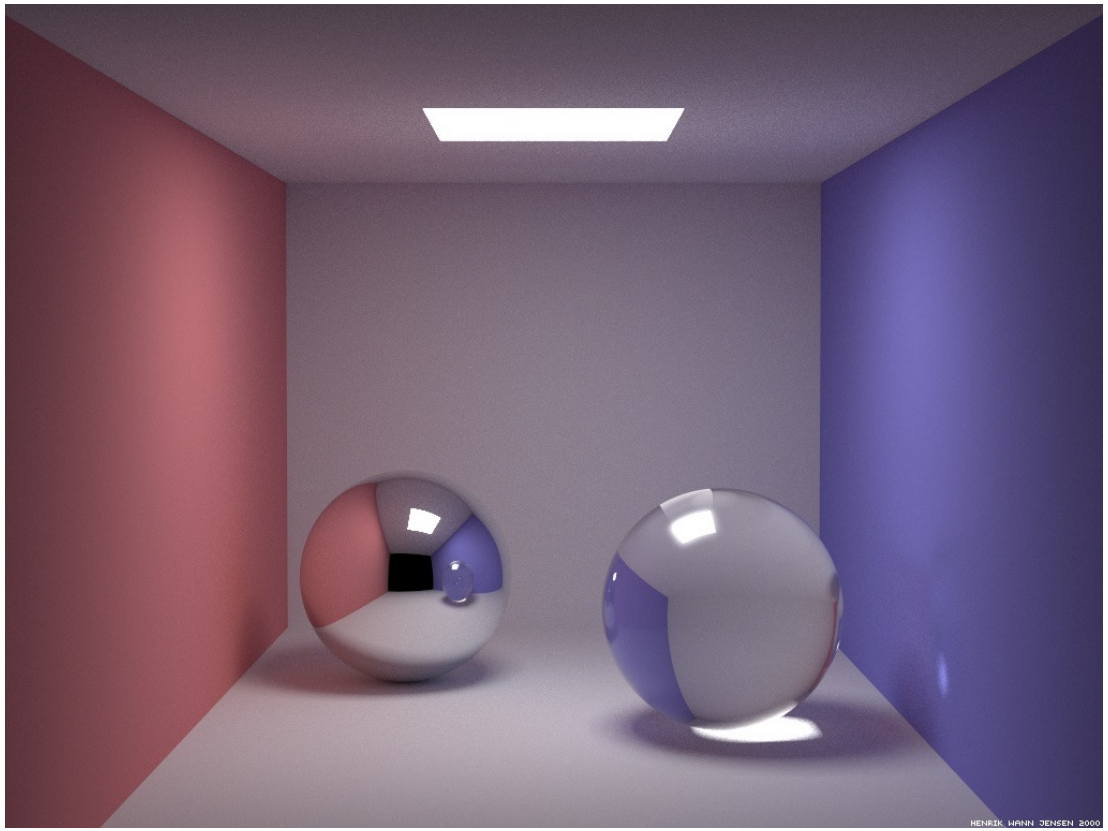
(Bild: nvidia)

https://www.youtube.com/watch?v=D1U1S5GzvJ8

Ray Tracing (Depth of Field)

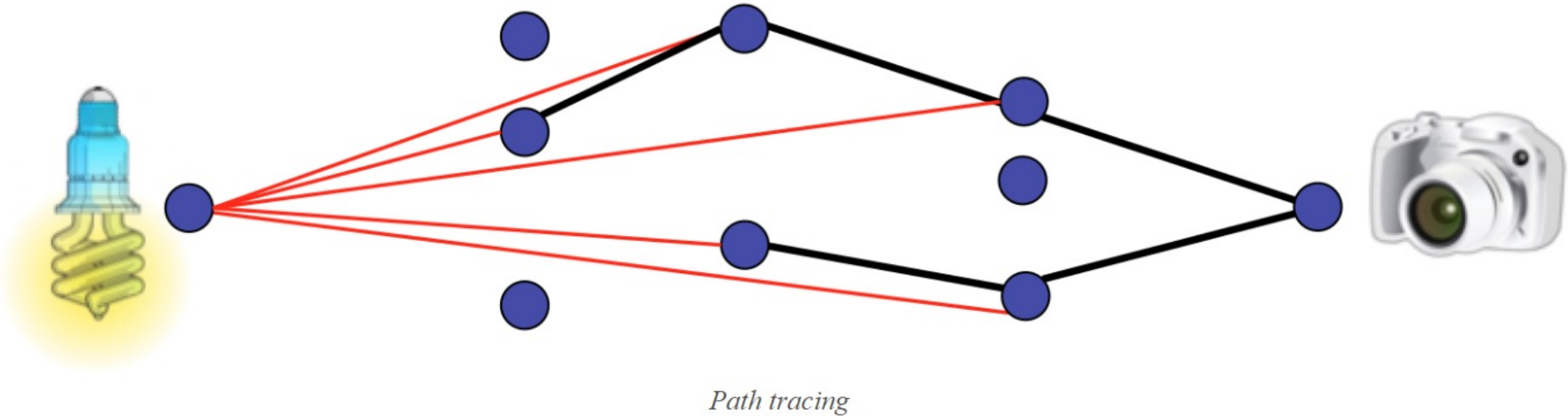
https://docs.unrealengine.com/4.27/en-US/RenderingAndGraphics/RayTracing/

What is missing?

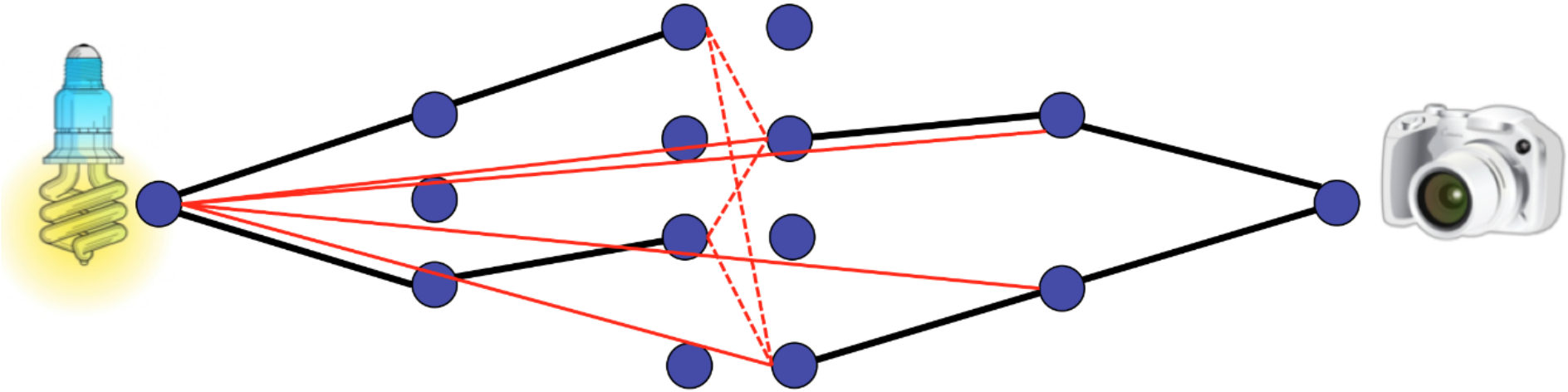


Photon Mapping

Path Tracing



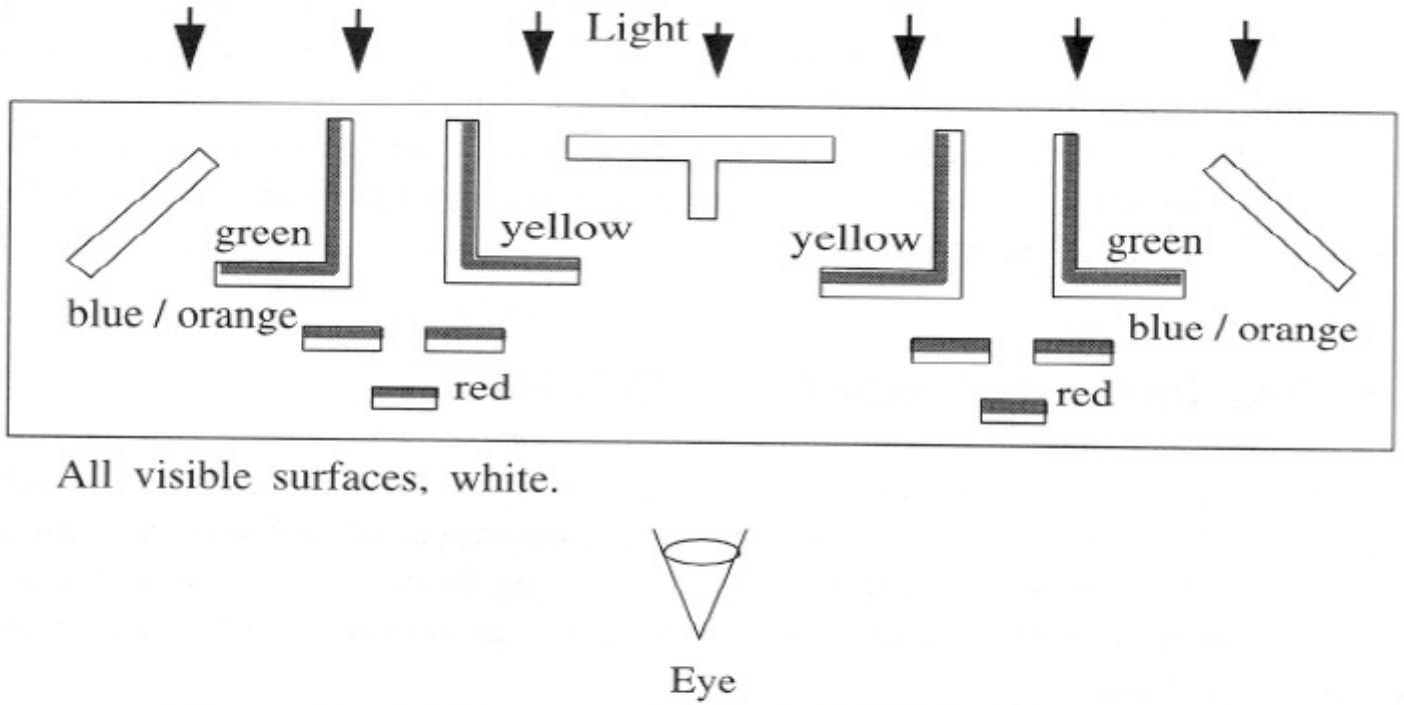
Path tracing



Bidirectional path tracing

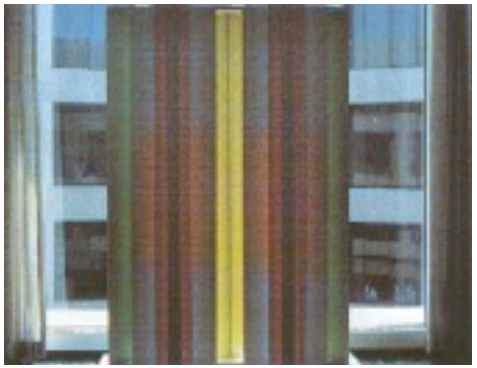
Images from GRAPHICS CODEX: https://graphicscodex.courses.nvidia.com/app.html

Global Illumination

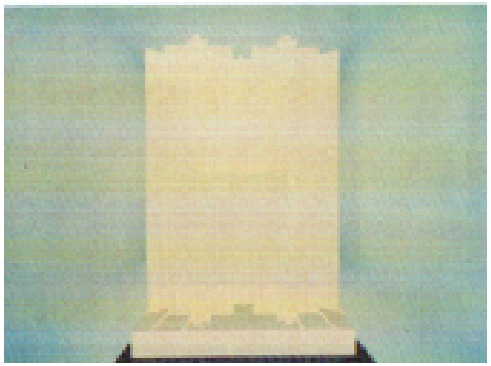


A Daylight Experiment, John Ferren

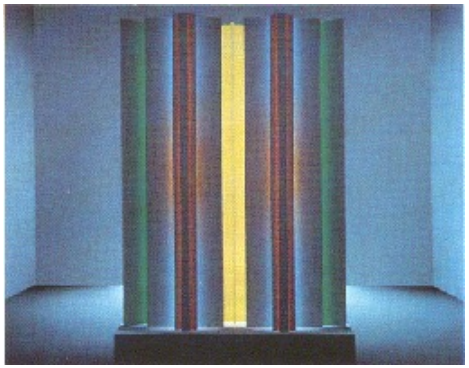
Global Illumination



- Photo



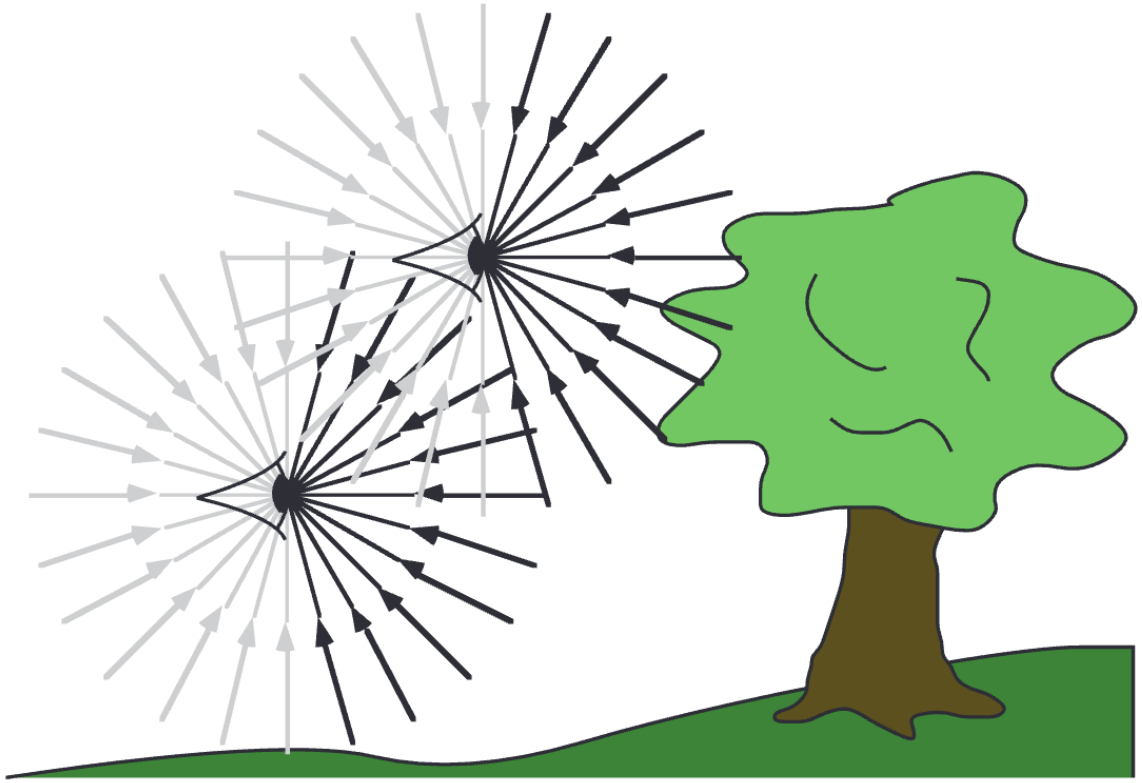
- Ray Tracing



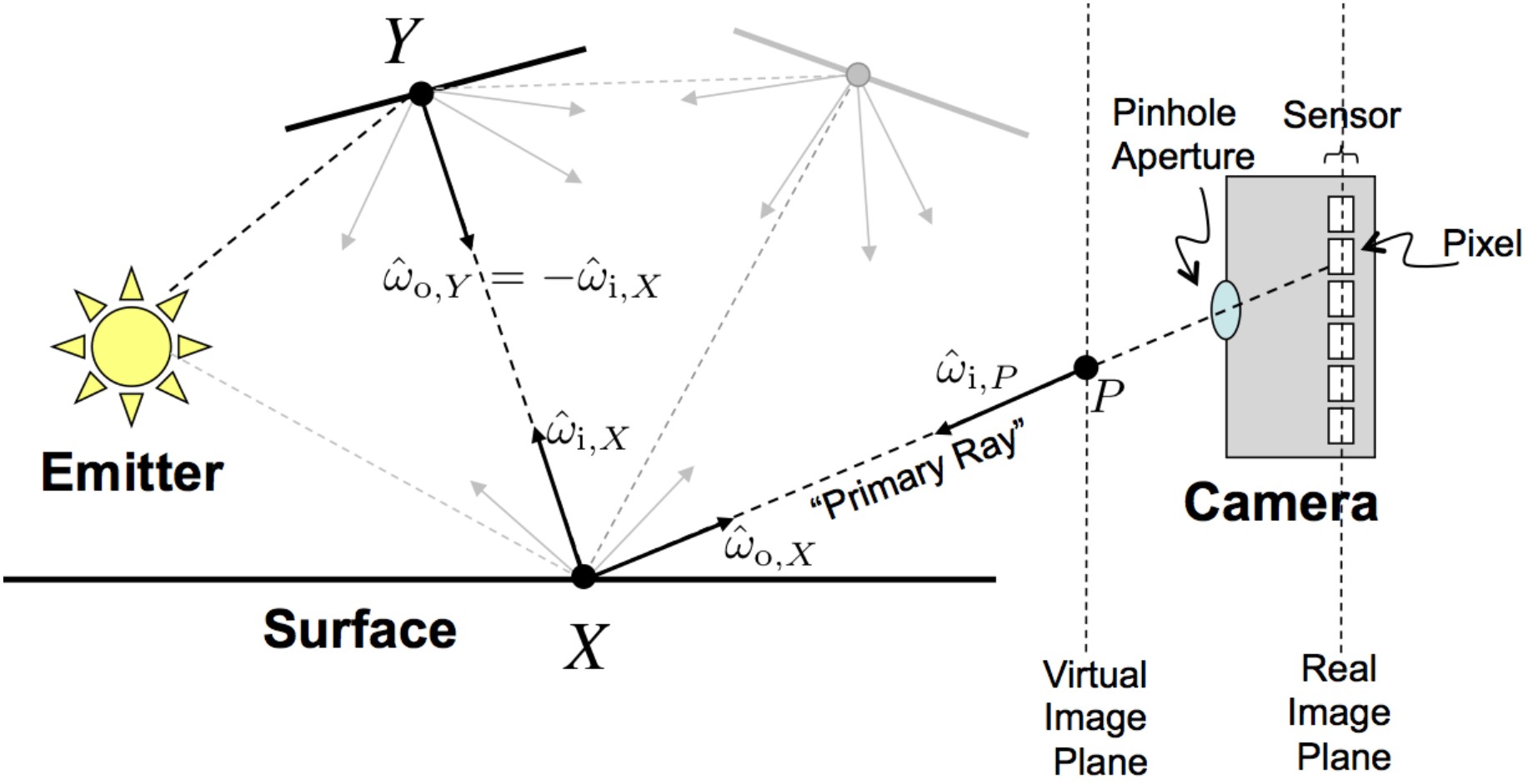
- Radiosity

Plenoptic function

The plenoptic function describes all the information available to an observer anywhere in space and time



Rendering Equation



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