CS451
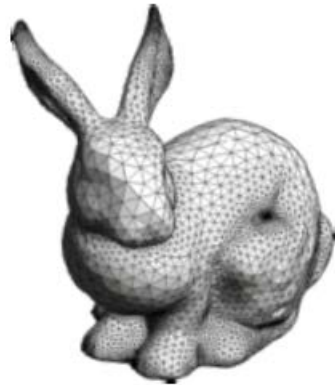# Ray Casting

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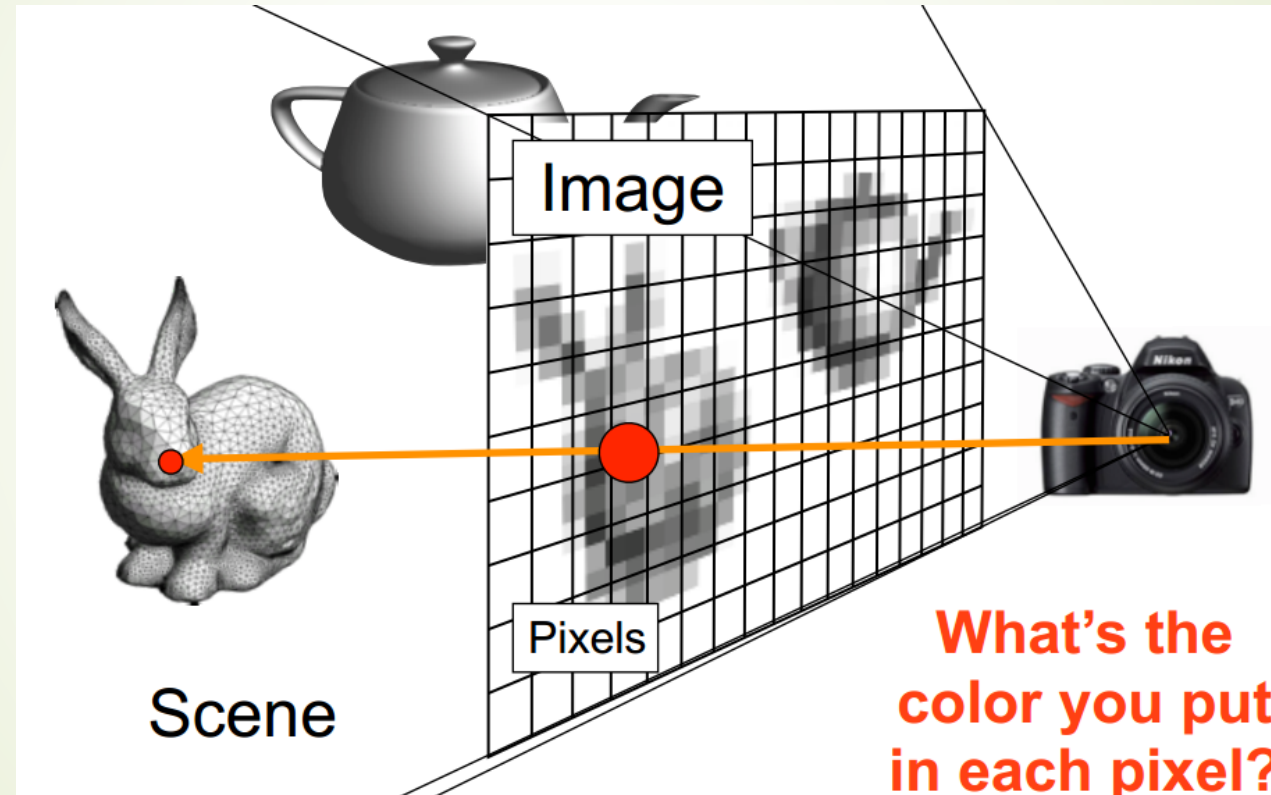# Rendering Review
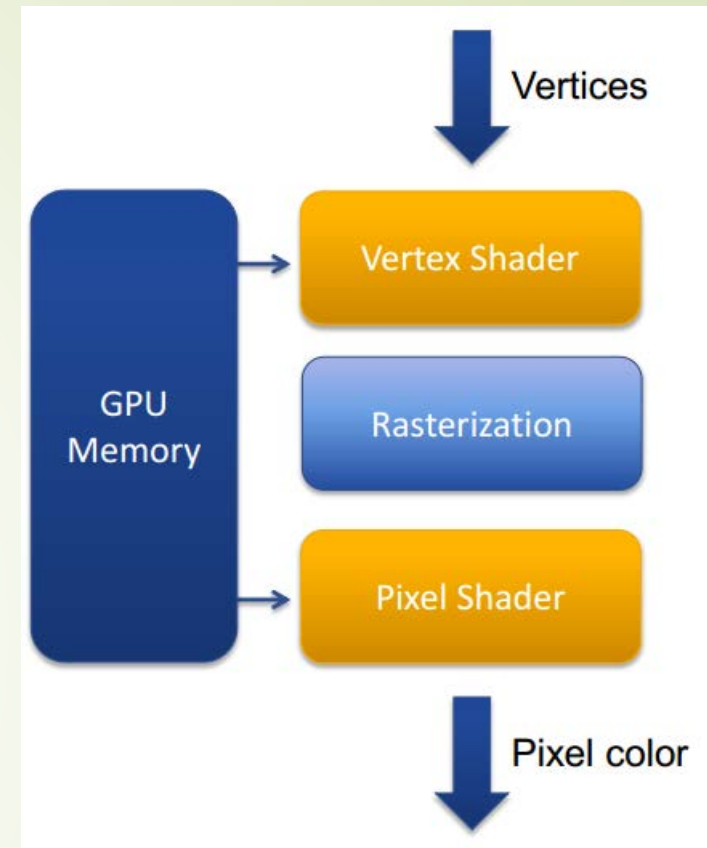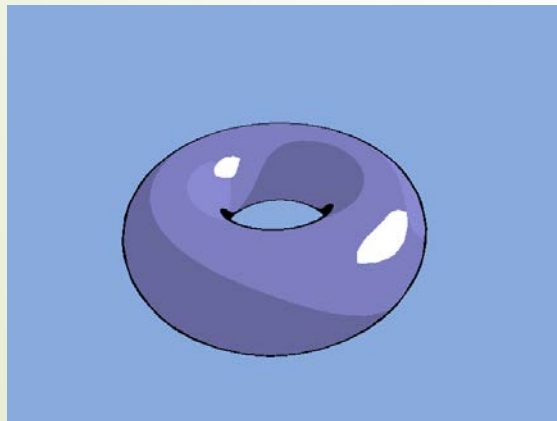
Rendering Review

Projection-Based Rendering

- Projection-based Rendering
  - Lights: directional, point, spot
    - Interact with vertices
  - Shading
    - determine pixel's colors
    - Ex: GLSL fragment shaders
  - Programmable pipeline opens up many possibilities
    - relief mapping, deferred rendering, non-photo realistic rendering (e.g. toon shading, cel shading), etc
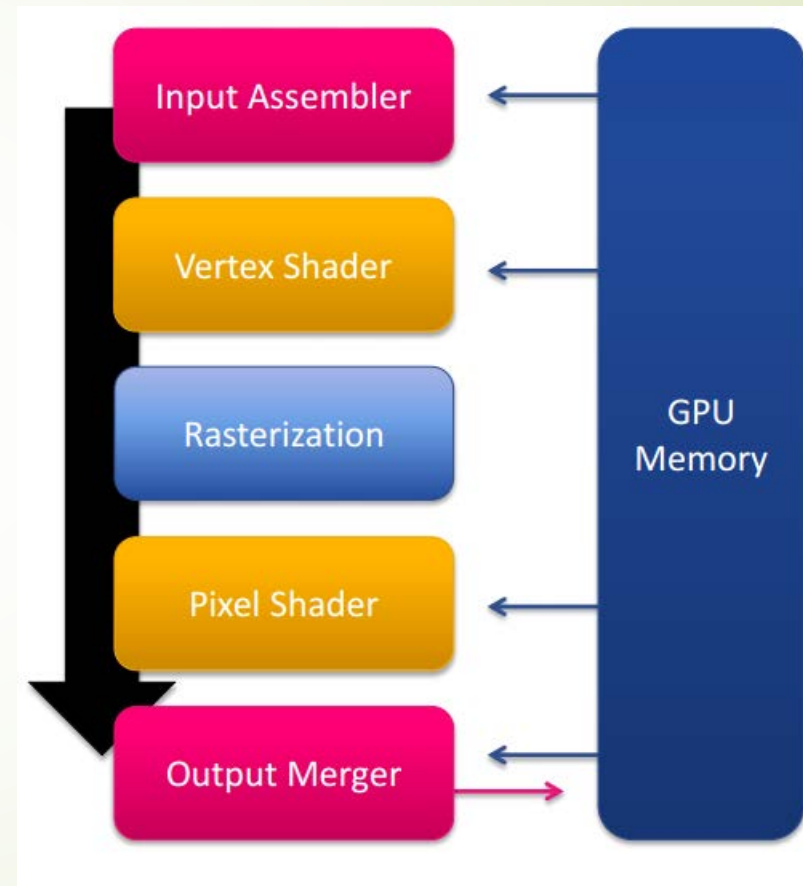
Non-Photo Realistic Rendering

GLSL Toon Shading Demo

Projection-Based Rendering

- More on programmable pipeline
- Input Assembler
  - Before Vertex Shader
  - Assembles data:
    - Vertex Buffer
    - Index Buffer
    - PrimitiveType
- Output Merger
  - After Pixel Shader
 - Z-buffer testing
  - Blending
  - Write to render target

Ray Casting

- For every pixel
  - Construct a ray from the eye
  - For every object in the scene
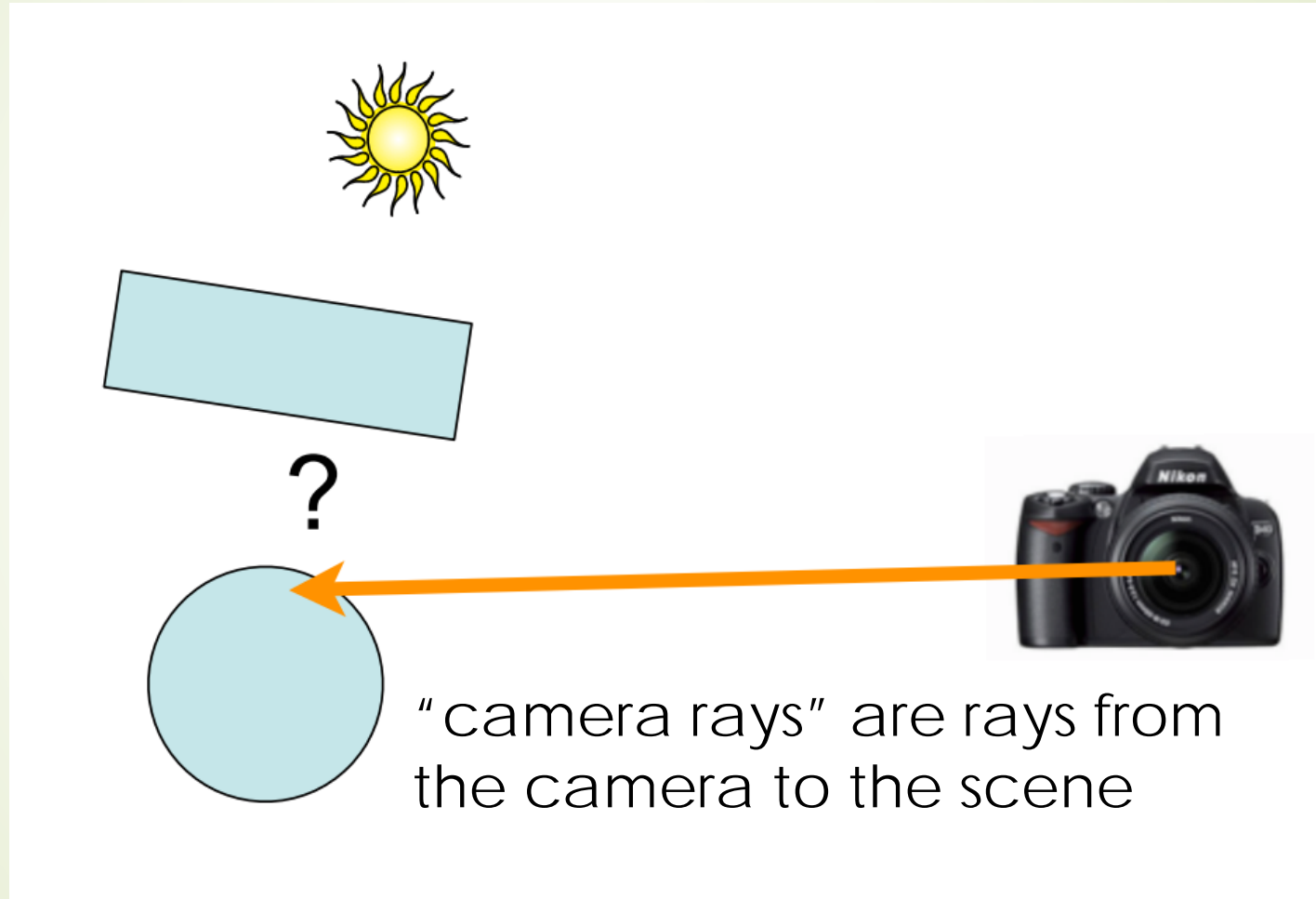 - Find intersection with the ray
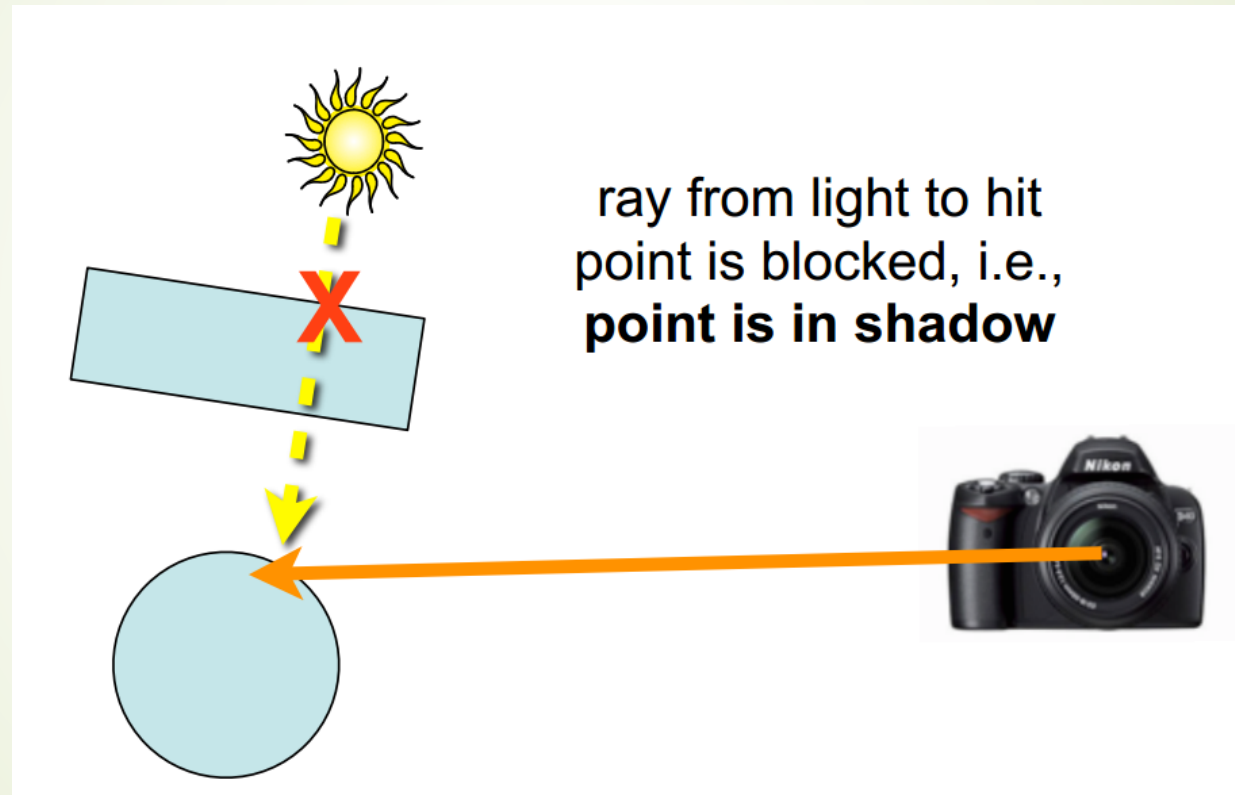 - Keep if closest
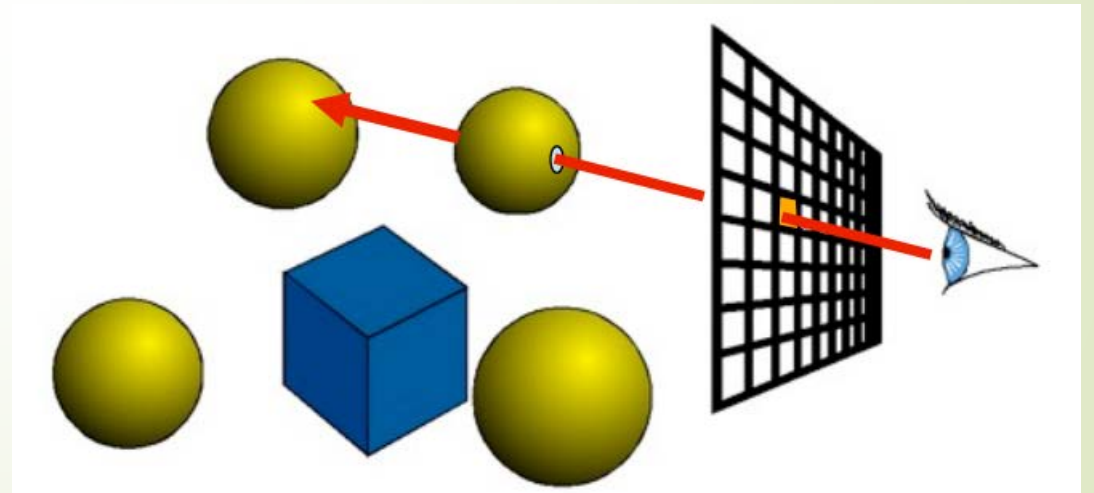
Ray Casting Based Shading

- For every pixel
  - Construct a ray from the eye
  - For every object in the scene
  - Find intersection with the ray
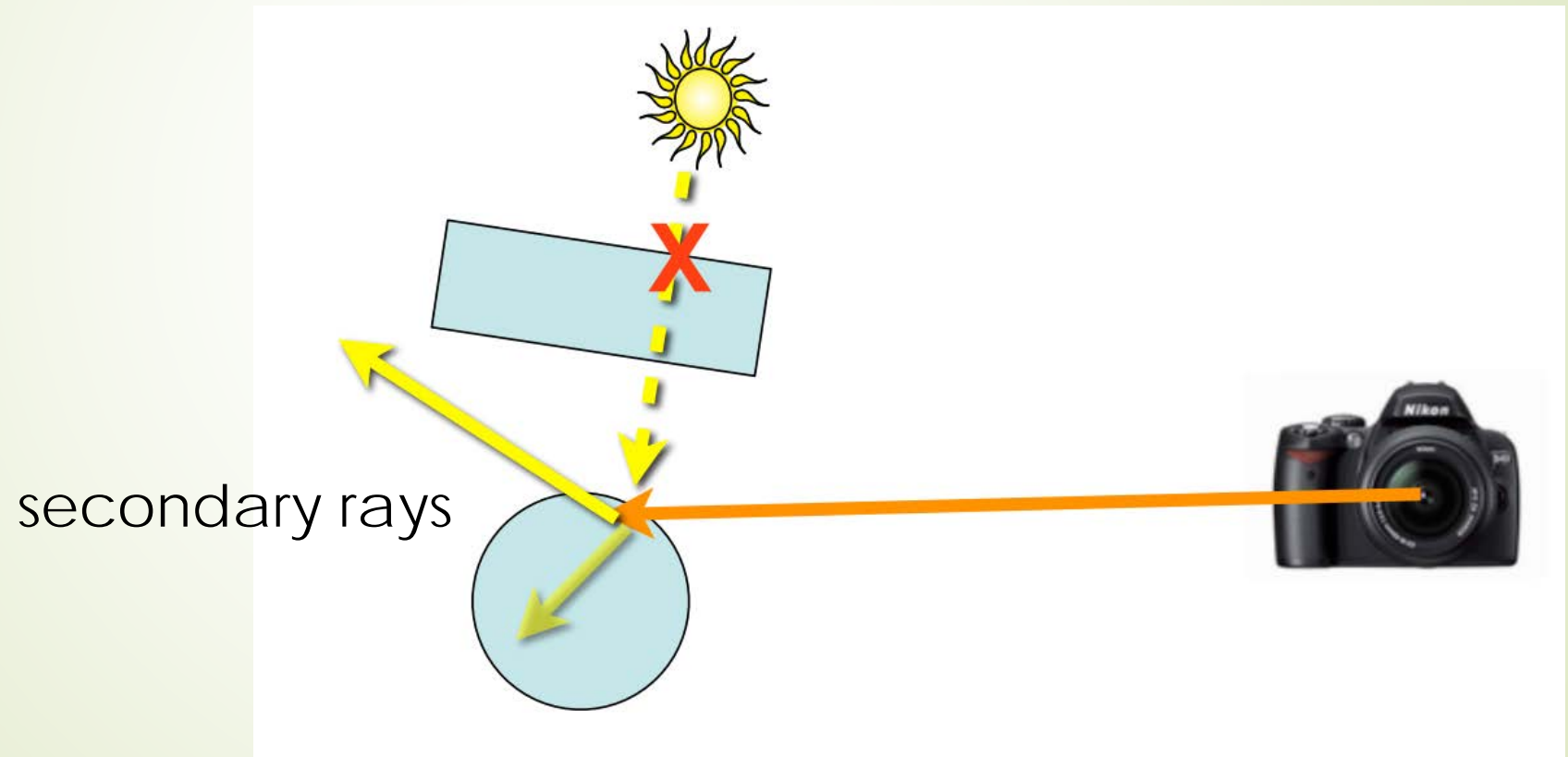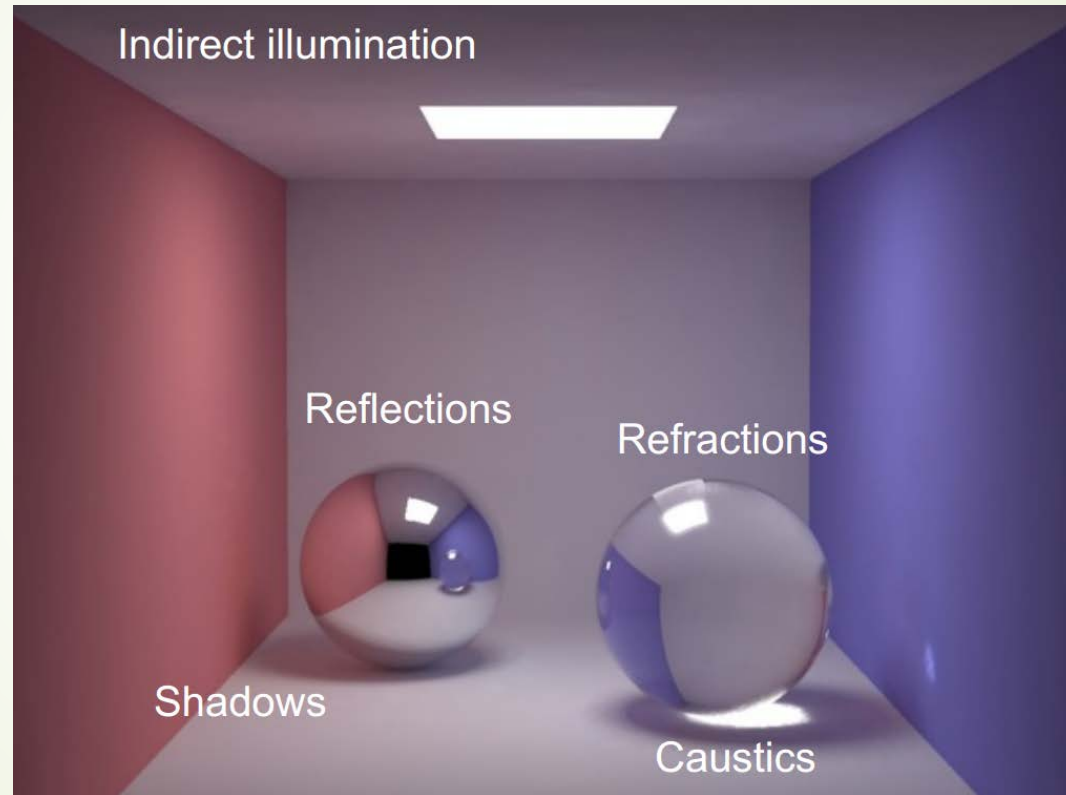 - Keep if closest
  - Shade

Ray Casting

"camera rays" are rays from the camera to the scene

Ray Casting Shadow
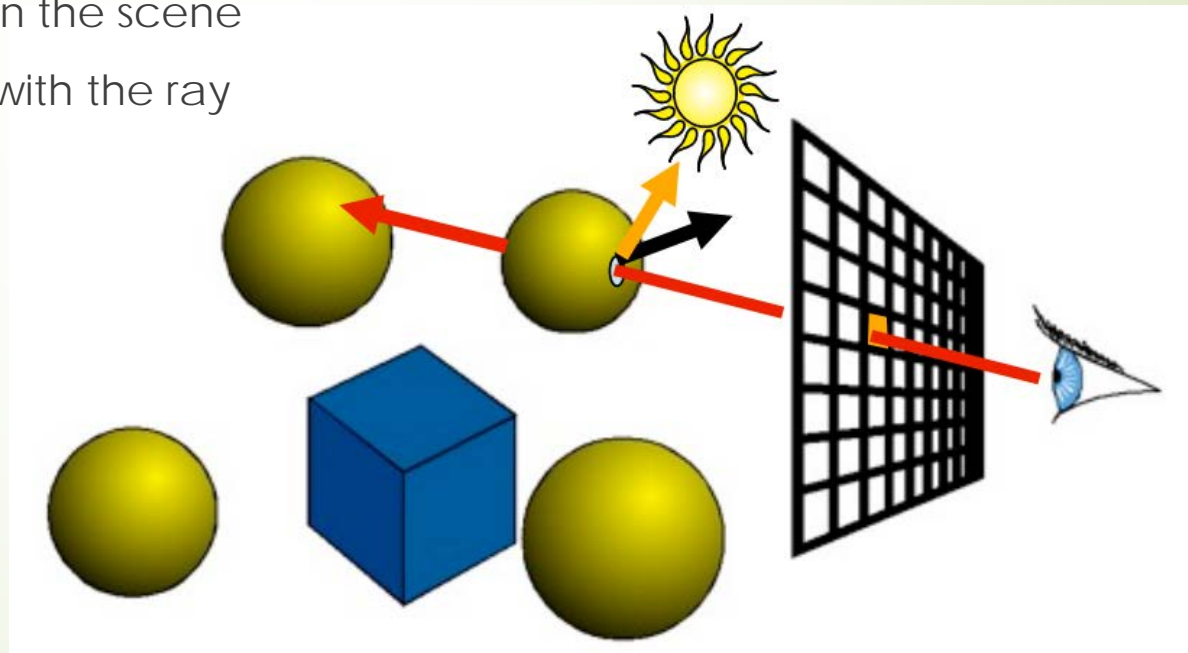
ray from light to hit
point is blocked, i.e.,
point is in shadow

Ray Tracing

- Ray casting = eye rays only
- Ray tracing = include secondary rays
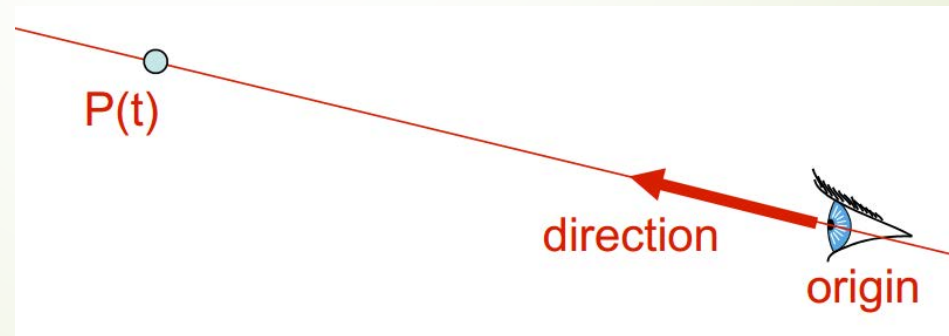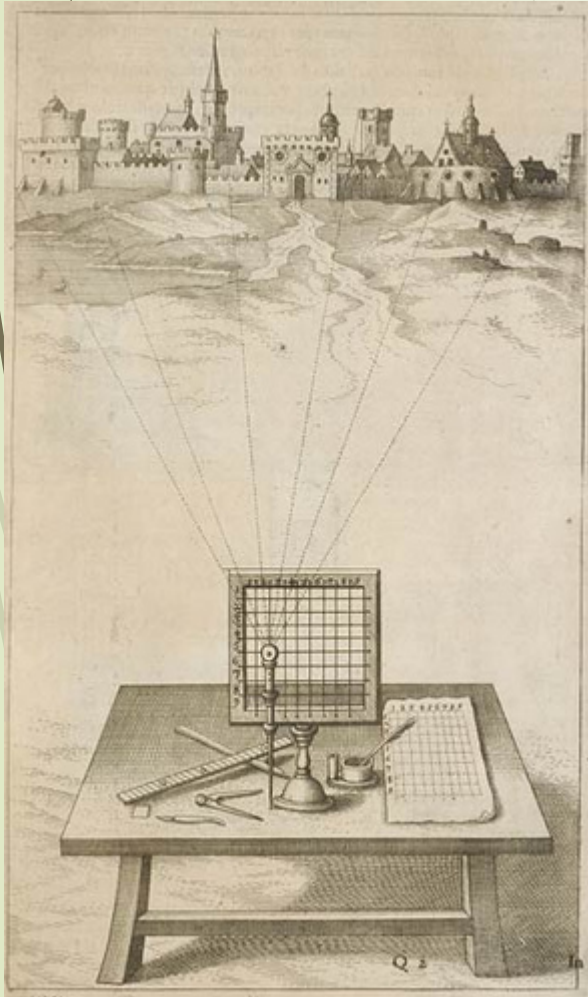

secondary rays

Questions?

Ray

- Representation
  - Origin (Point)
  - Direction (Vector)
- Parametric line
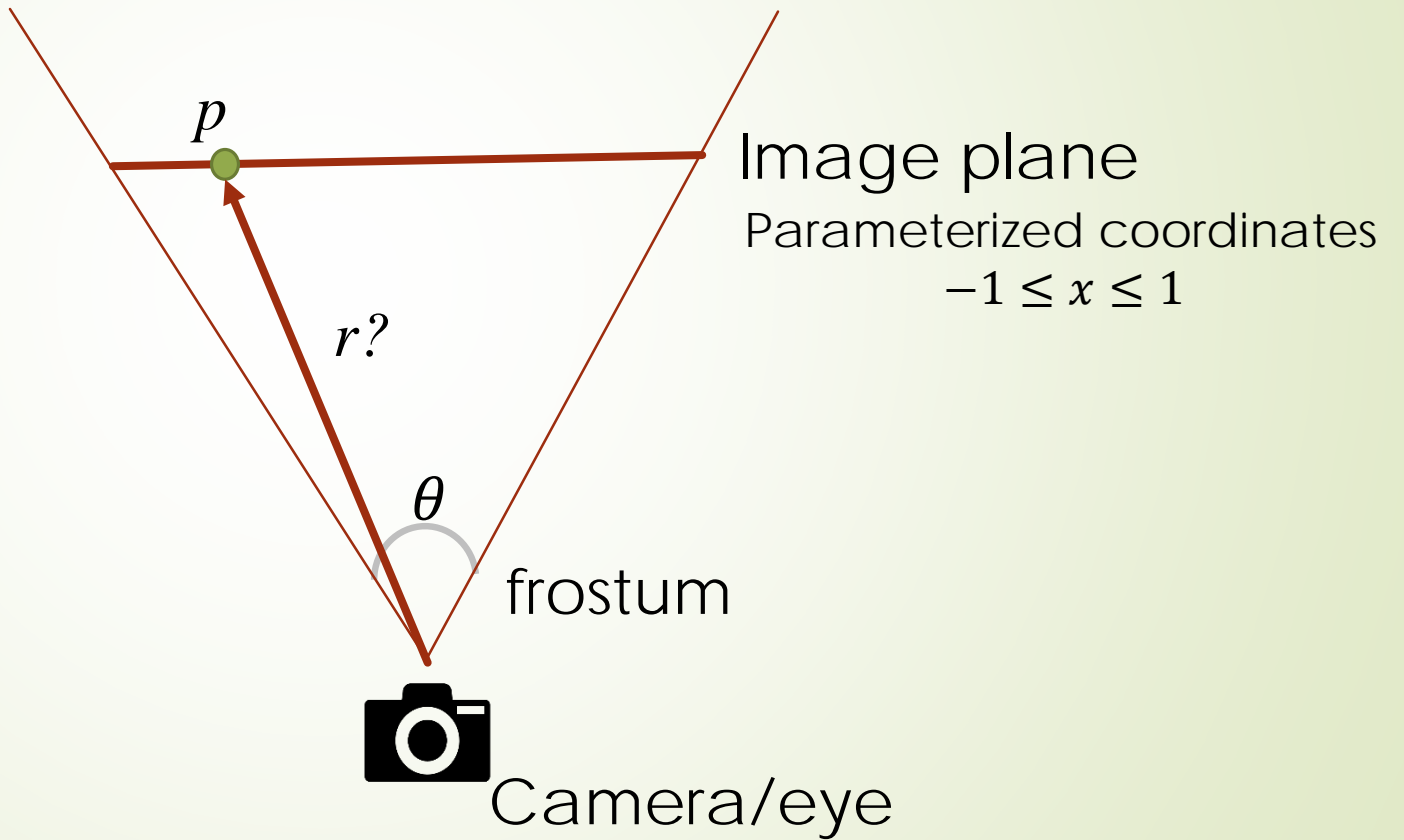 - $P(t) = O + tV, \forall t > 0$

Albrecht Durer's Ray Casting

- Dürer demonstrates the device Alberti called a 'veil'.
  - The screen and corresponding grid on the artist's drawing paper are repeated for the viewer in the pattern of windows looking over a landscape.

http://aauerbach.info/research/theory/theoretical_eye.html
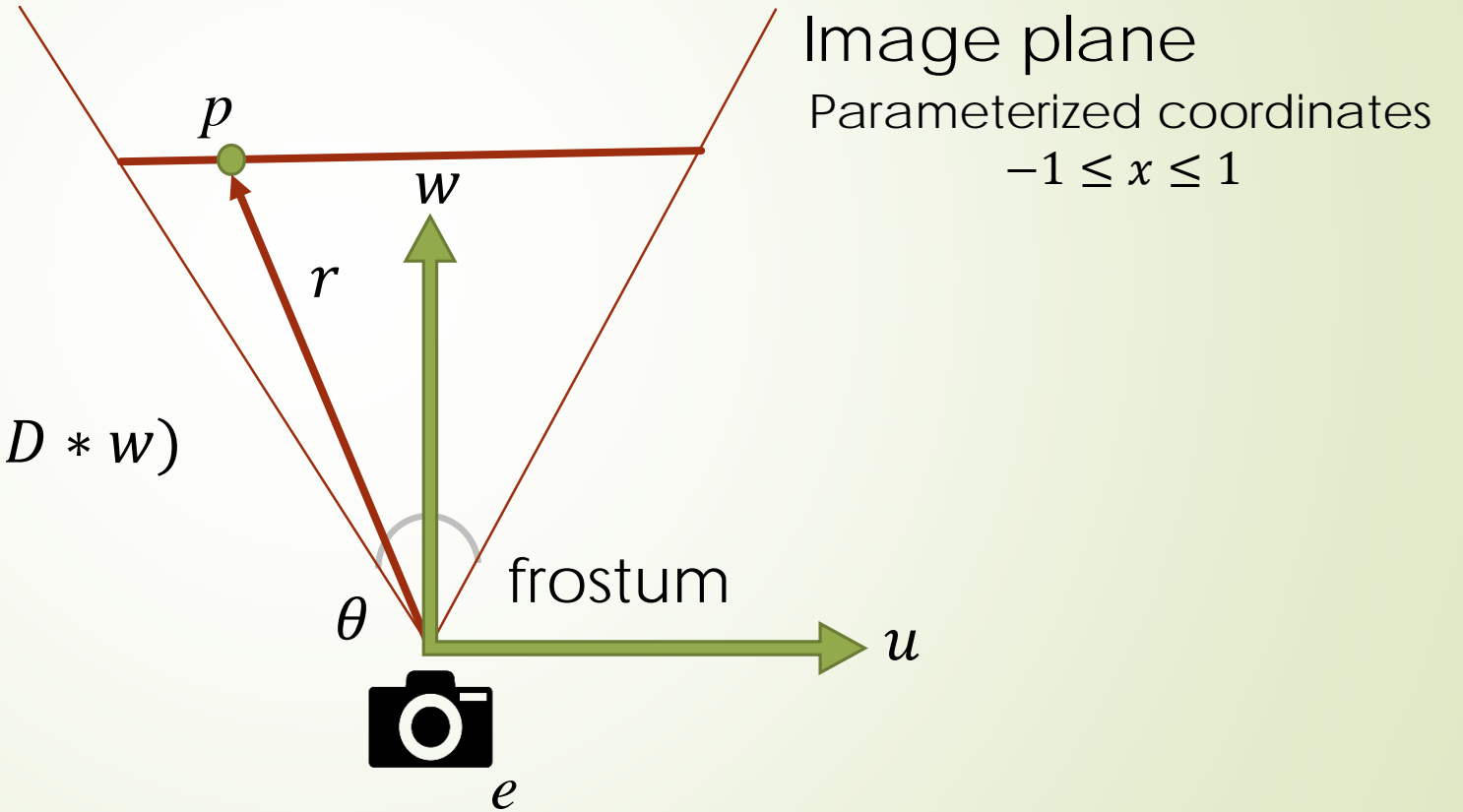
Ray Generation

- In 2D

p

Image plane
Parameterized coordinates
$-1 \leq x \leq 1$

$r?$

θ

frostum

Camera/eye

Ray Generation

- In 2D

Image plane
Parameterized coordinates
$-1 \leq x \leq 1$

p

w

r

$r = p - e = (x * u, D * w)$

$D = \dfrac{1}{\tan(\theta/2)}$

θ

frostum

u

e

Ray Generation

- In 3D

Image plane
Parameterized coordinates
$$-1 \leq x \leq 1$$
$$-1 \leq y \leq 1$$

p

w

r

$$r = (x * u, A * y * v, D * w)$$

A is the aspect ration

$$D = \frac{1}{\tan(\theta/2)}$$

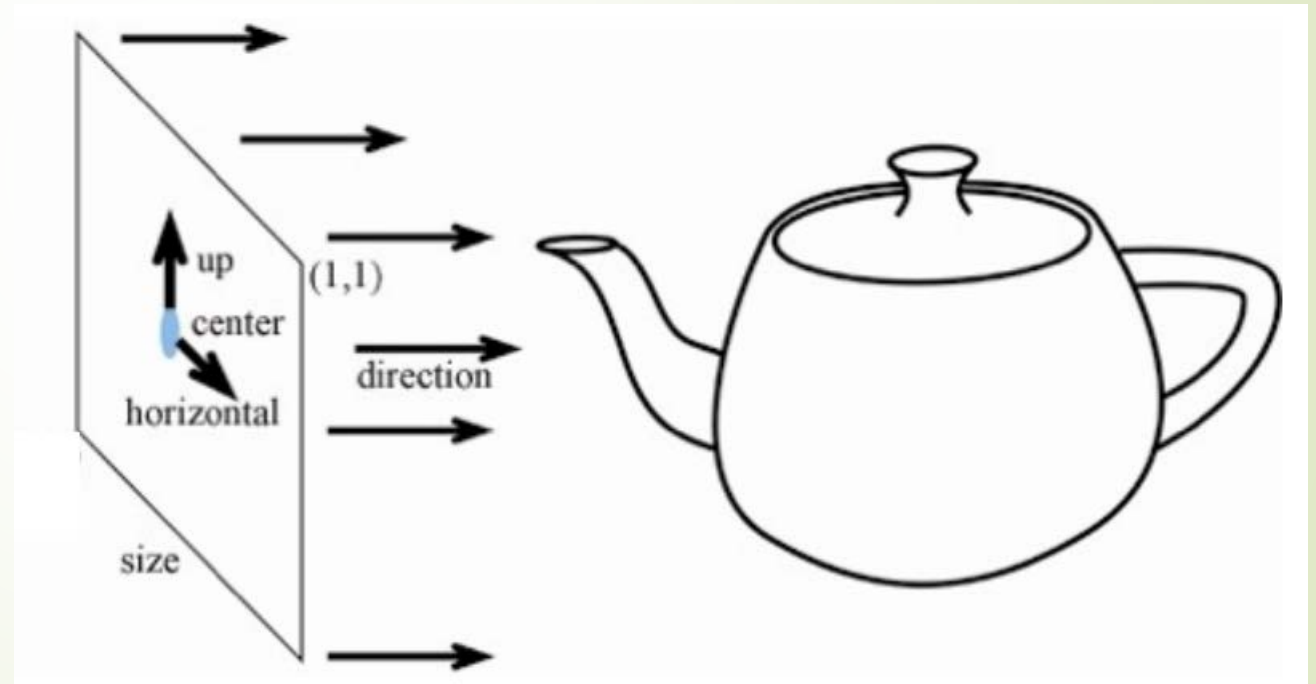frostum

θ
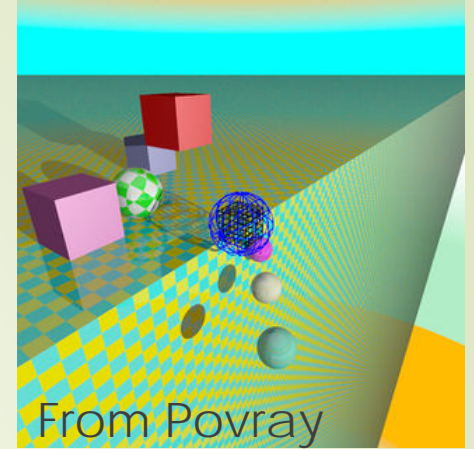
u

v

e
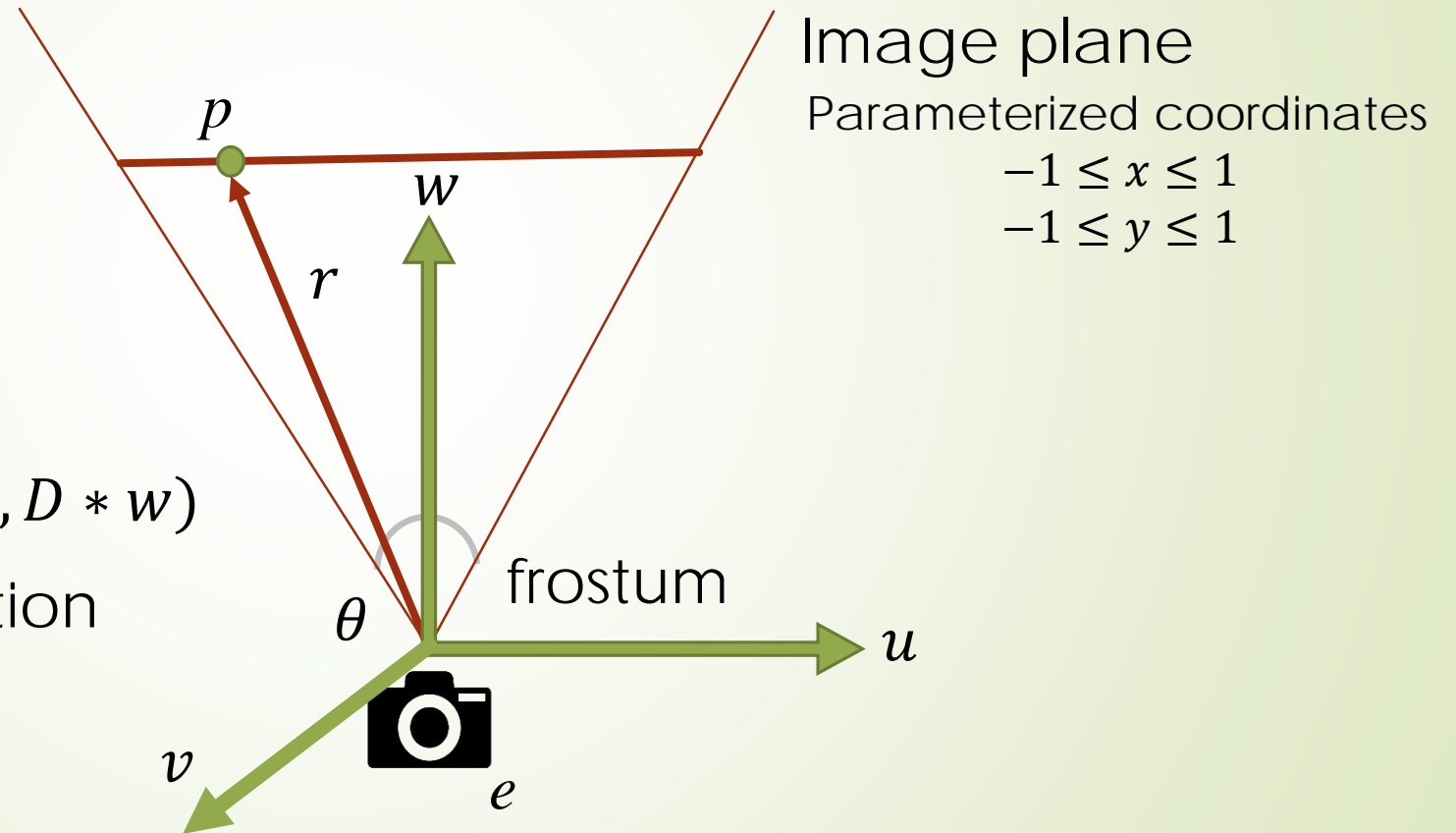
Ray Generation for Orthographic Camera

- Orthographic Camera
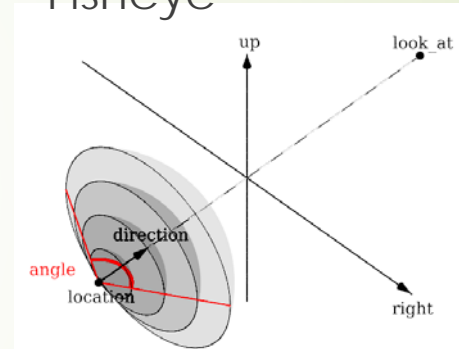 - Origin =
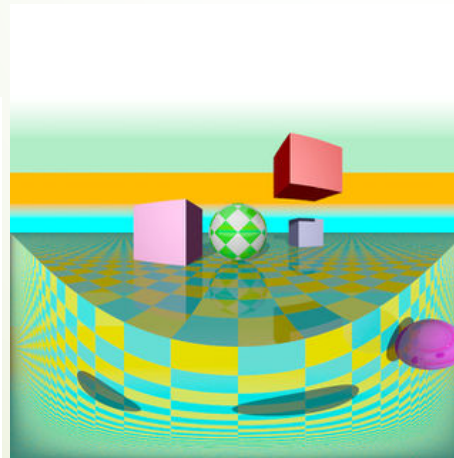 - Direction =
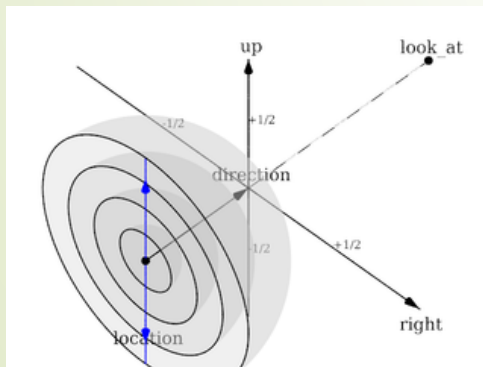
Other Types of Cameras

From Povray

- Fisheye (spherical projection)
- Omnimax (Imax dome)
- Panoramic camera
- …

Fisheye

Panoramic

Omnimax