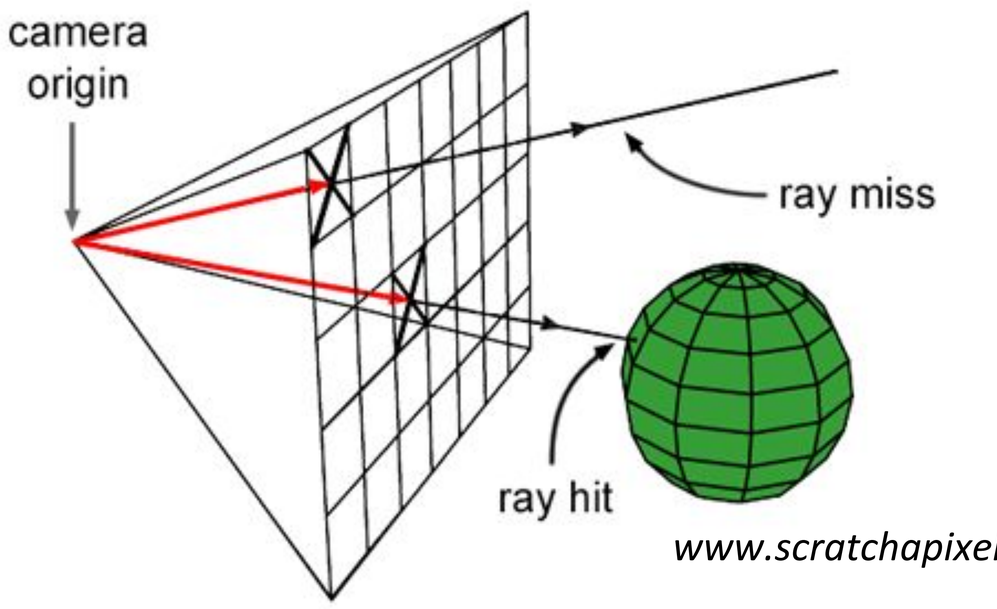
Photorealistic Rendering Based on Ray Tracing

Ian Wang
Oregon State University

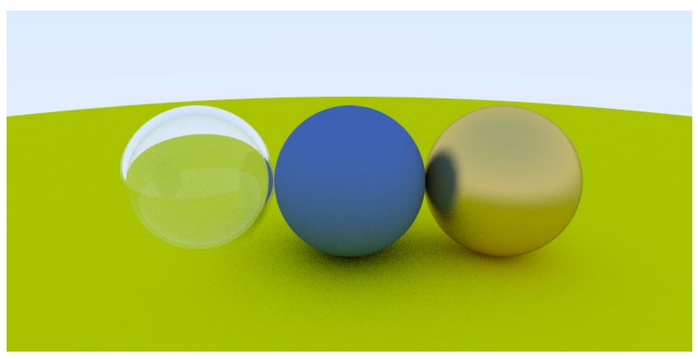
What is Ray Tracing?

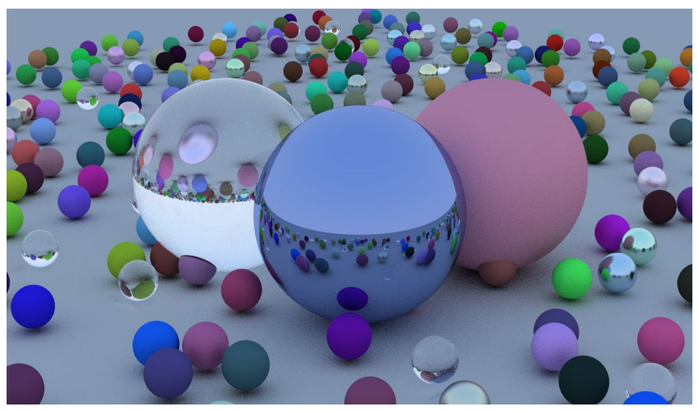
- Generate rays from an origin to check for intersection with object, if intersect, return color to pixel
- Primary rays for color, secondary rays for shadow and light to produce realistic images
- Computationally expensive - requires time
- Commonly used to animate movies and video games



www.scratchapixel.com

Examples of Ray-Traced Images





In real life, different materials reflect light in different ways. We are able to use shadow rays to simulate how light interacts with different materials: (glass, metal, mattes, etc.)

References:
Shirley, Peter. *Ray Tracing in One Weekend*

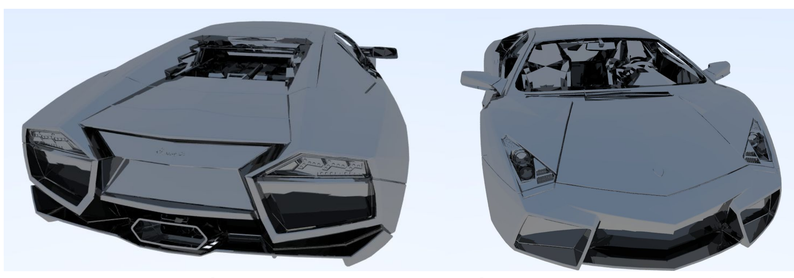
Ray-Triangle Intersection & 3D Meshes

$$\begin{bmatrix} t \\ u \\ v \end{bmatrix} = \frac{1}{(D \times E_2) \cdot E_1} \begin{bmatrix} (T \times E_1) \cdot E_2 \\ (D \times E_2) \cdot T \\ (T \times E_1) \cdot D \end{bmatrix} == \frac{1}{P \cdot E_1} \begin{bmatrix} Q \cdot E_2 \\ P \cdot T \\ Q \cdot D \end{bmatrix}$$

- The **Möller-Trumbore Algorithm** is a ray-triangle intersection equation
- Create a 3D mesh out of triangles and trace each one to render the image
- Quick and efficient method

1600x1200 pixels, 968 triangles, 18 sec. render time

Lamborghini Reventón

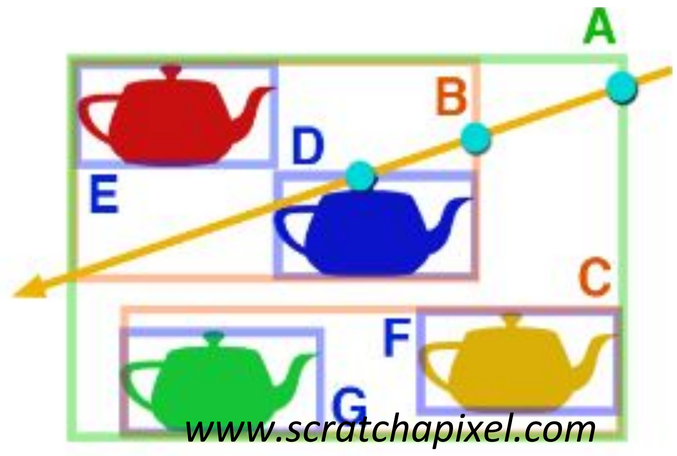


3840x2160 pixels, 21386 triangles, 446 sec. (7.4m) render

Accelerating Ray Tracing

- Put objects in **bounding boxes**
- When testing for intersection, eliminate unnecessary tests by only testing the boxes the ray intersects

In this example, the ray only tests intersections in box D because the ray does not hit any other boxes



www.scratchapixel.com

Thanks to:
Dr. Eugene Zhang, Dr. Yué Zhang,
Mr. Jinta Zheng, Mr. Kevin Hung,
ASE Saturday Academy, and Oregon State University