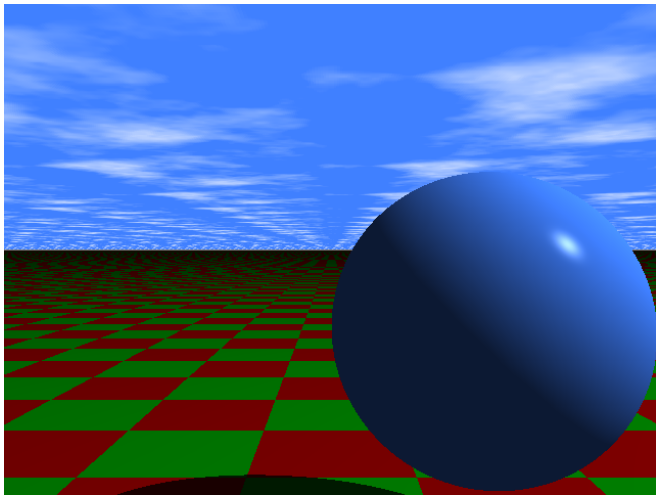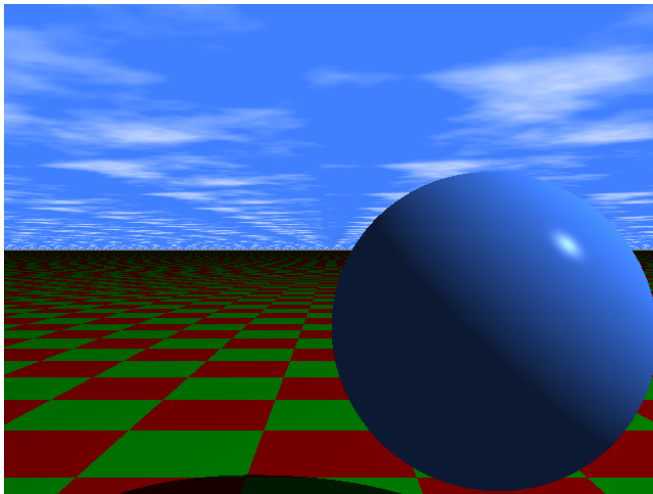# Ray Tracing, Part IV

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A simple scene

A simple scene
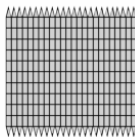

- How do we get more than one color on an object?

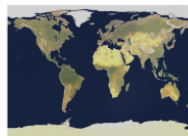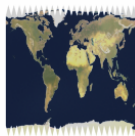# Textures and UV mapping

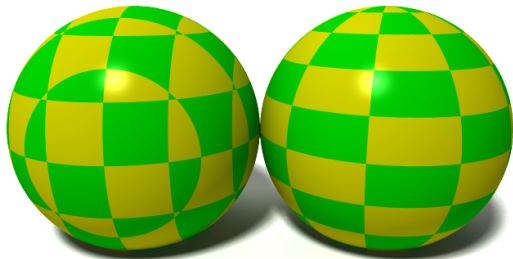**3-D Model**   **UV Map**
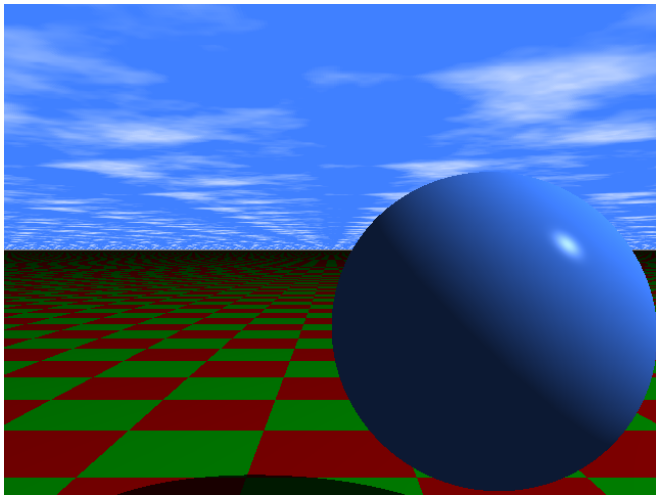
$p = (x,y,z)$ $p = (u,v)$ **Texture**

▶ Need to map point on surface to point in image.
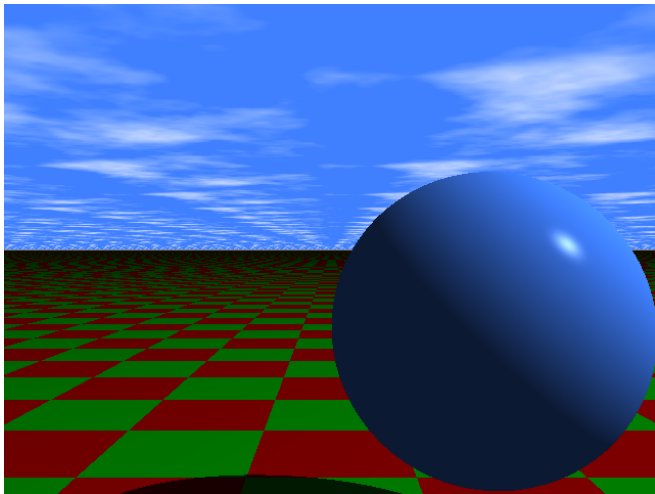
2D and 3D mapping

- Can be *procedural* rather than image texture.

A simple scene

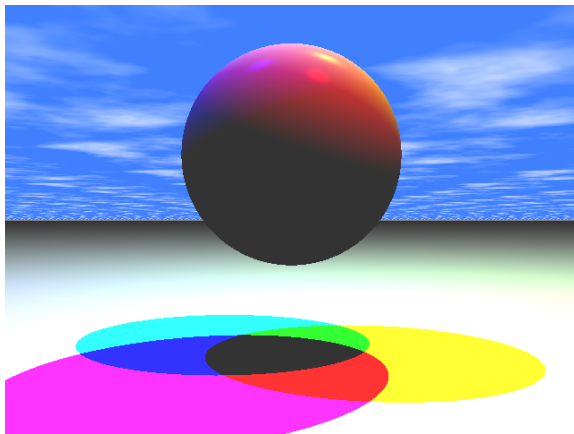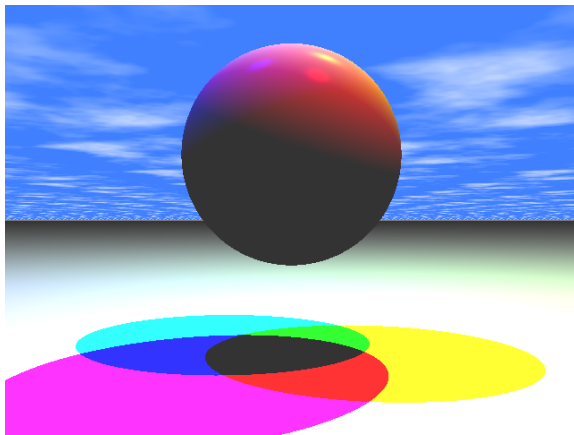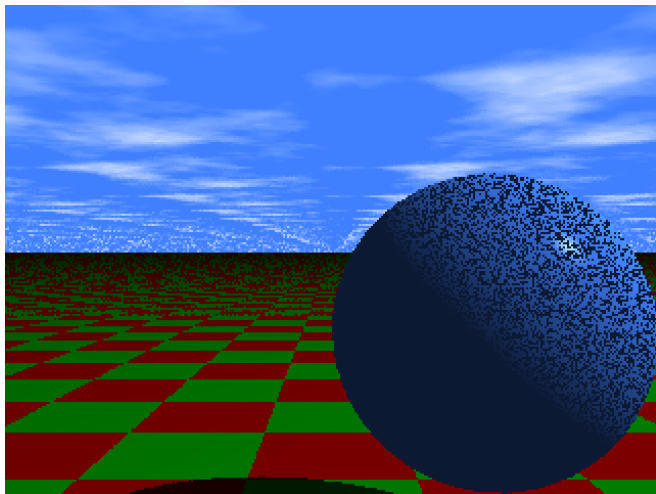# A simple scene

▶ How did we get the shadow?

Shadows

- Cast a ray from intersection to lights.
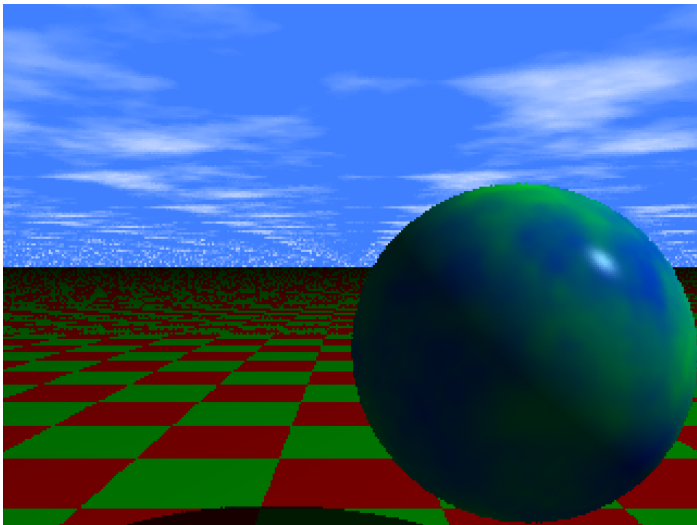- Do not need closest intersection, can quit after one.

Shadows

- Cast a ray from intersection to lights.
- Do not need closest intersection, can quit after one.
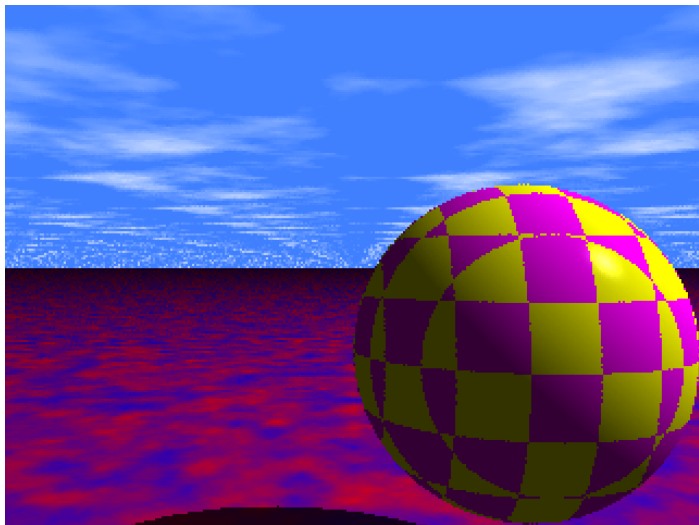- Colors in shadows?

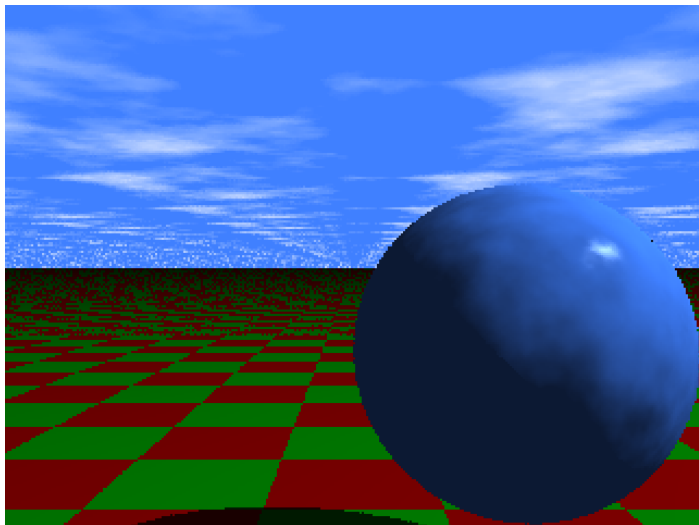# False Self-intersections

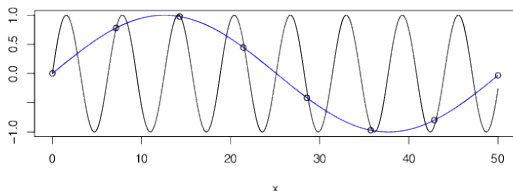- Numeric problems with intersections.

Noise texture

# Alternate scene

Noise texture bumpmapped

Aliasing

- ▶ Sample the black line at widely spaced gaps.
- ▶ Smoothly connecting the samples gives a signal of a much longer wavelength.
- ▶ The high frequency signal is masquerading, or **aliased** as a low frequency signal.
- ▶ All computer graphics is done at **pixels**, which are regularly spaced **samples**. *Pixels are not little squares!*
- ▶ Aliasing is a constantly recurring problem in computer graphics.
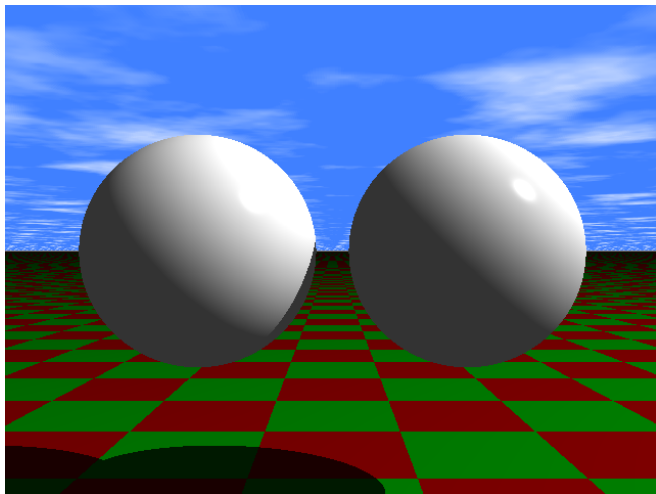
Aliasing in the simple scene
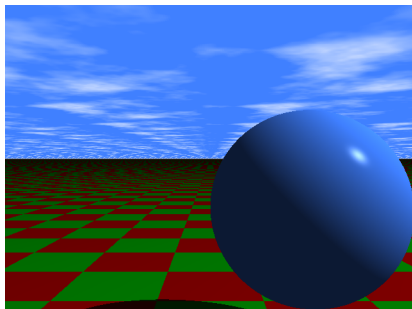
- Some visible artifacts
    - Jaggies on the edge of the sphere.
    - Large patches of color on the ground.
    - New patterns in the distant clouds.
- Some solutions to aliasing
    - Sample at random points in pixel area.
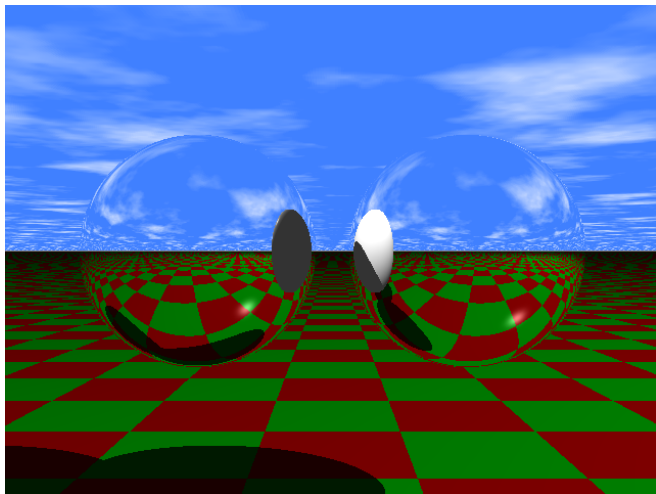   - Resample multiple points in the pixel area.
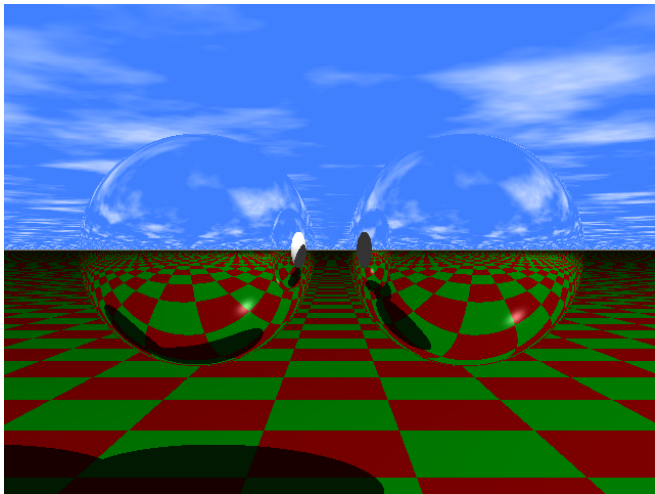
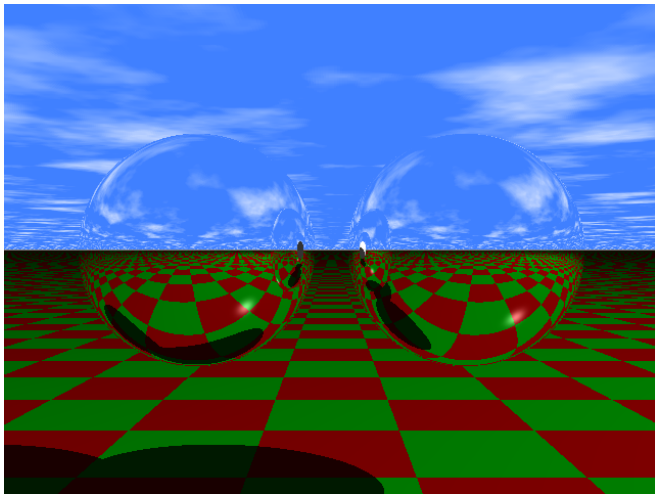# Reflections: Whitted Raytracing
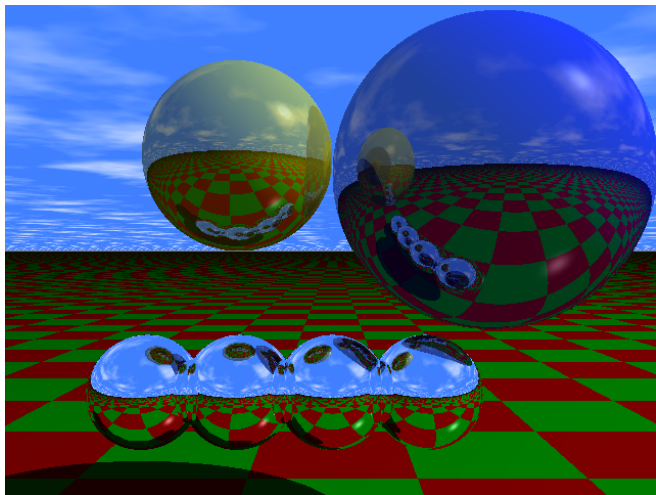
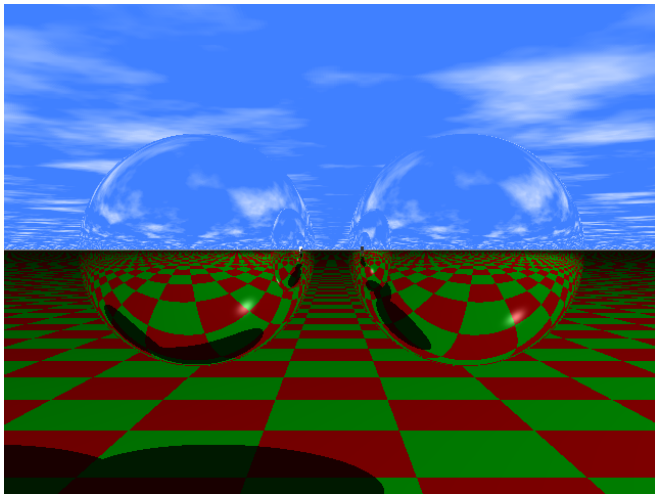# Reflections: Recursion Limit

Reflections: Recursion Limit

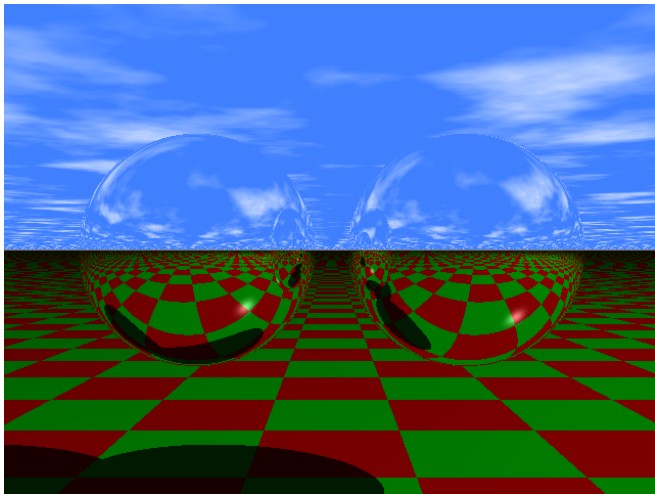# Reflections: Recursion Limit

Reflections: Recursion Limit

Reflections: Recursion Limit
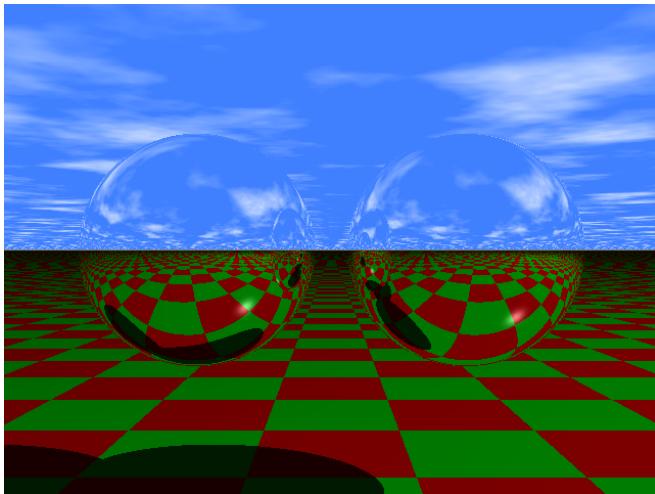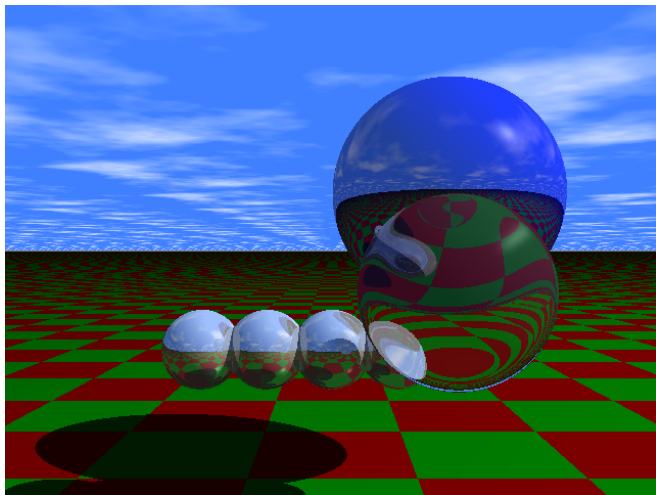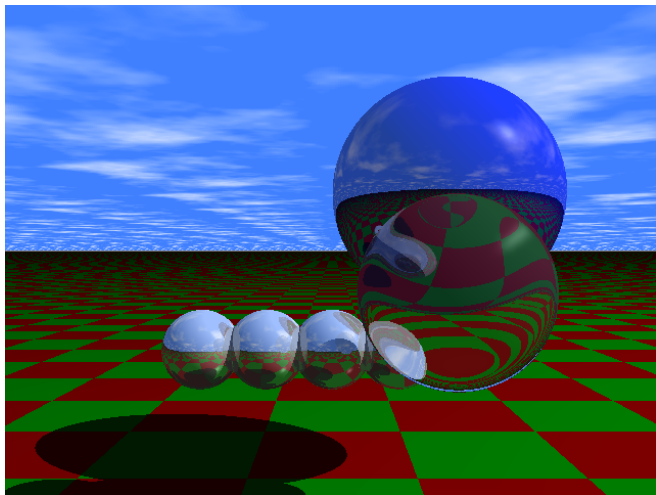
Reflections: Recursion Limit

Reflections: Recursion Limit

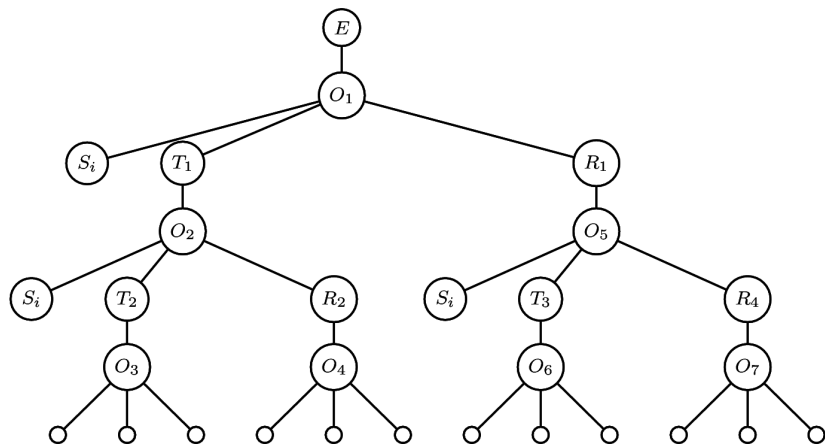# Refractions: Whitted Raytracing

Refractions: Whitted Raytracing

- What about shadows if the object is transparent? Caustics?

The Ray Tree

Speeding up ray tracing

- ▶ Embarassingly parallel
- ▶ Object partitioning

Readings

- http://scratchapixel.com/lessons/3d-basic-lessons/lesson-1-writing-a-simple-raytracer/
- http://en.wikipedia.org/wiki/Ray_tracing_(graphics)
- http://www.cs.unc.edu/~rademach/xroads-RT/RTarticle.html
- http://en.wikipedia.org/wiki/Phong_lighting
- http://www.wiziq.com/tutorial/162719-6-837-7-Ray-Tracing-Computer-Graphics
- http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/

Software:

- http://pbrt.org/
- http://www.luxrender.net/en_GB/index
- http://www.povray.org/
- http://www.yafaray.org/
- http://radsite.lbl.gov/radiance/HOME.html
- http://www-graphics.stanford.edu/~cek/rayshade/rayshade.html