

More Ray Tracing!



- Efficiency
- Boolean operations
- Antialiasing

A comment on attenuation



- Attenuation
 - Light through air (as we use in OpenGL)
 - Refraction and reflection contribution

Efficiency: Intersection Calculations



- Pre-computation
- Re-orientation
- Bounding volumes
 - For complex objects
- Hierarchies of bounding volumes

Efficiency: Intersection Calculations



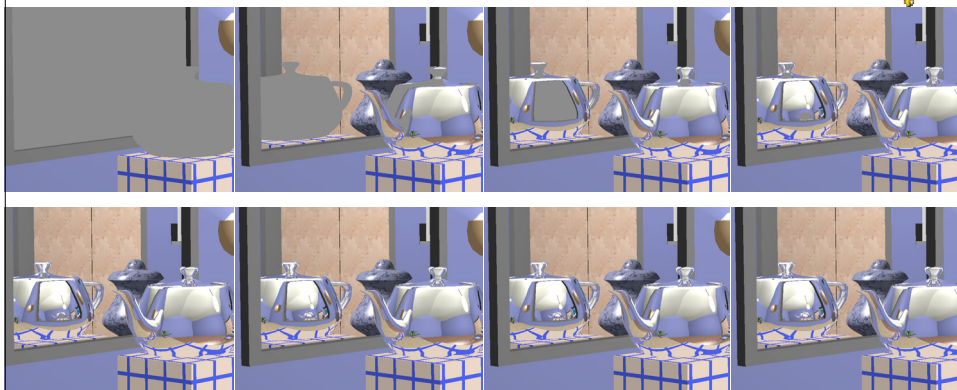
- Spatial partitioning
 - Regular or unequal sized subdivisions
- Associate object with each partition
- Intersect rays with partitions
 - Intersect rays with object in partitions

Efficiency: Depth Control



- Maximum recursion depth
 - Usually have some fixed max
- Adaptive tree-depth control
 - Recurse only if contribution significant
 - Potential problem: sum of parts

Example: Depth Control



Other Efficiency Methods



- Item buffers
 - Pre-render scene, (ab)use z-buffer

Other Efficiency Methods



- Light buffers
 - Bound light with grid box
 - Compute possible intersecting objects
 - Watch for opaque, full coverage objects
 - Shadow rays can determine which grid item they pass through
 - If farther than opaque object, stop
 - Only intersect list of possible objects

Boolean Sets



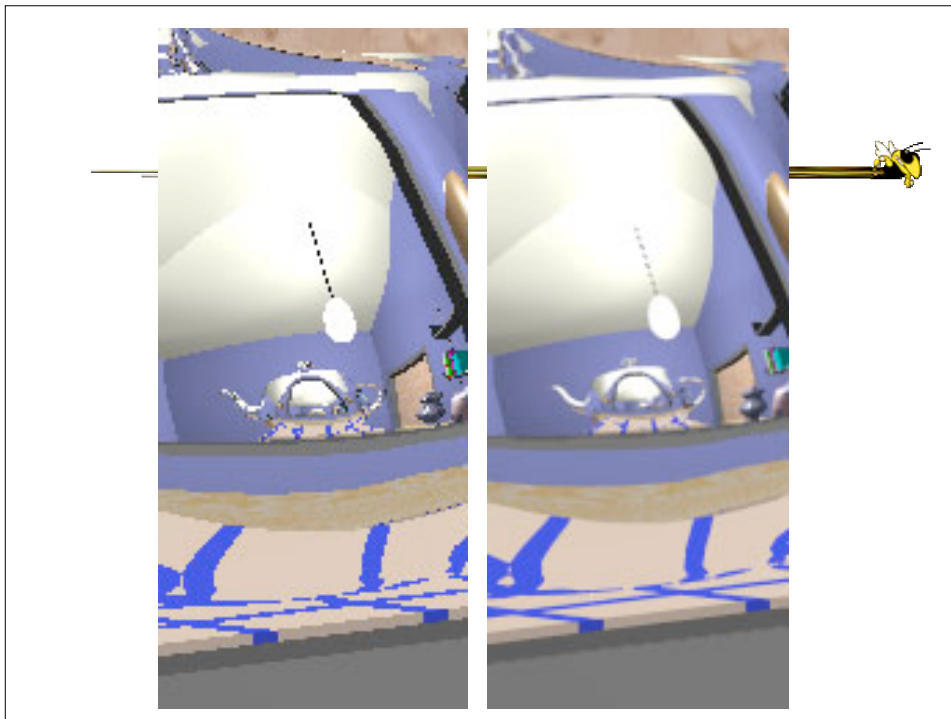
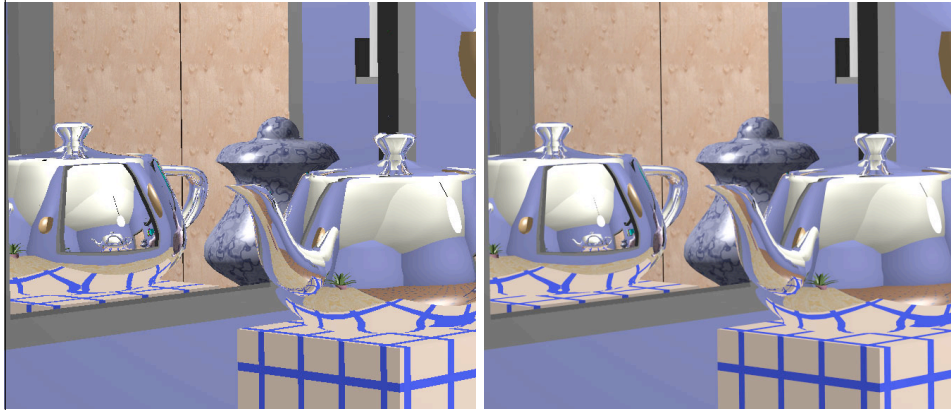
- Represent scene as solid objects
- Boolean ops: Intersect, union, difference
- Easy with ray tracing
 - Compute t range for intersection with objects
 - Perform 1D Boolean Set ops on t ranges

Antialiasing: Supersampling



- Regular supersampling
 - ie. Ray trace $nm \times nm$ image
 - $n \times n$ image with $m \times m$ samples per pixel
 - average the $m \times m$ samples
- Adaptive supersampling
 - Start with $(n+1) \times (n+1)$ (pixel corners)
 - subdivide pixel if values are "different enough"

Antialiasing Example



Temporal Aliasing: e.g. Small objects



- Object smaller than pixel
- Appear/disappear in moving scene
- One Solution
 - Surround by bounding volume that covers at least one pixel

Antialiasing: Distributed Ray Tracing

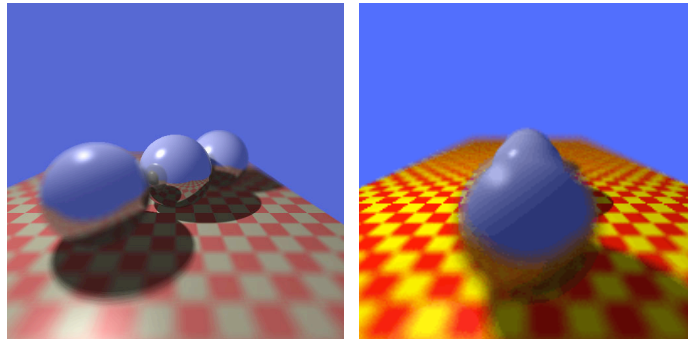


- "Distributed"
 - Stochastically distribute rays
- Ideal: min spaced distribution of rays
- Approximation:
 - randomly jittered supersampled grid

Distribute various dimensions



- Depth of field
 - Camera position/orientation



Other dimensions



- Motion blur
 - Time: Position of moving objects affected
- Soft shadows
 - Angle subtended by extended light source
 - Soften penumbra
- Gloss, Translucency
 - Material properties

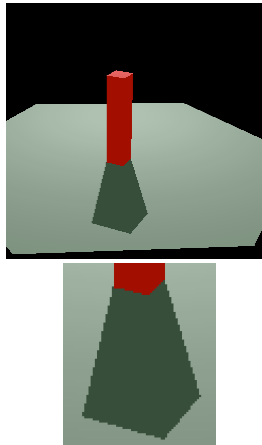
Motion Blur



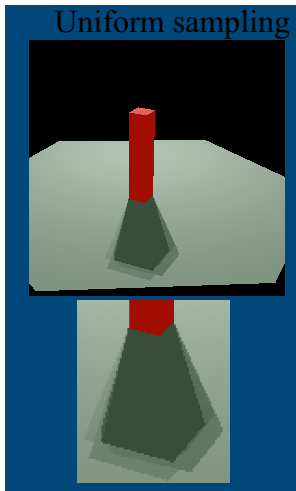
Shadows



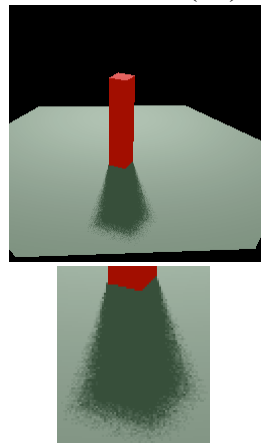
Hard



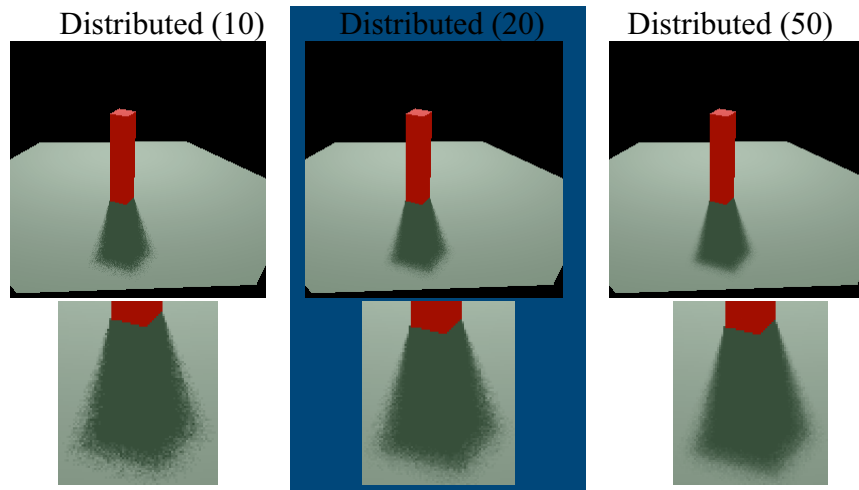
Uniform sampling



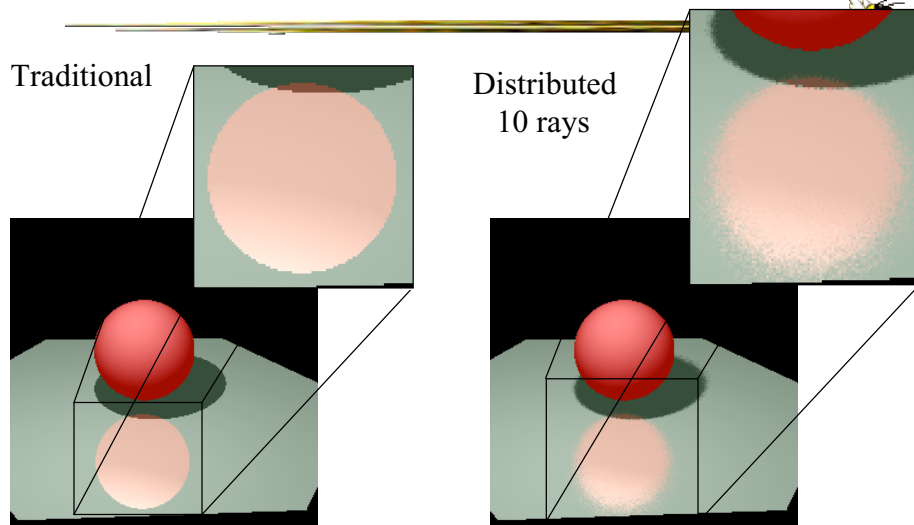
Distributed (10)



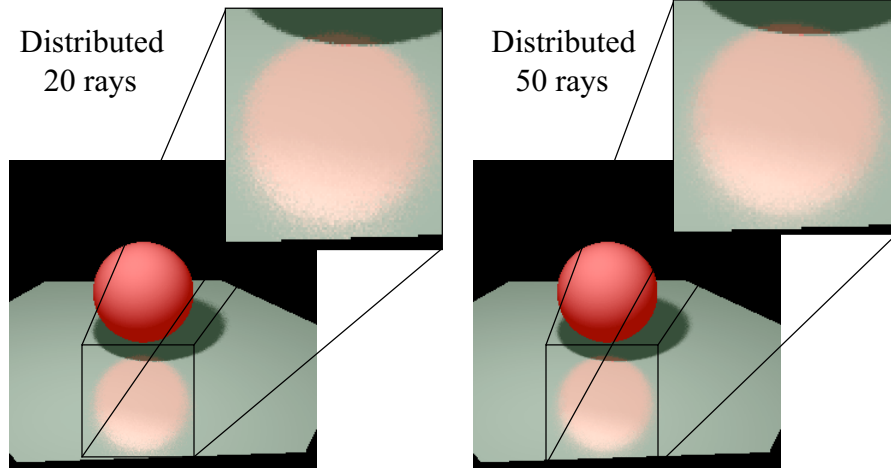
Shadows (cont.)



Gloss



Gloss (cont.)



Translucency

