CS130 : Computer Graphics

Ray Tracing (cont.)

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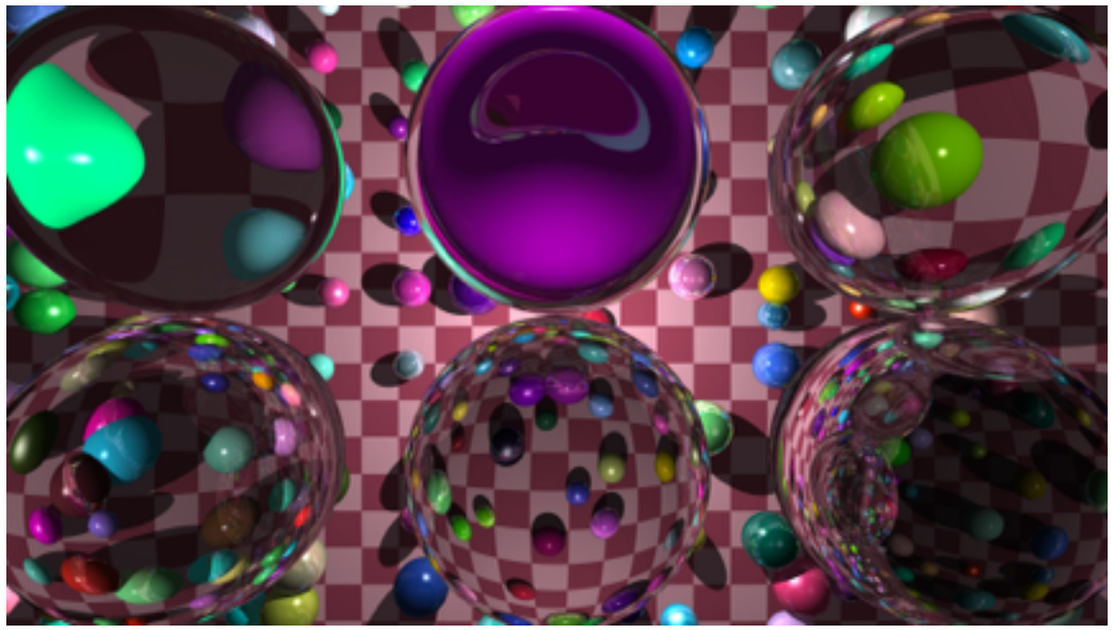
ray tracer extensions

- refraction
- more complex geometry
  - instancing
  - CSG
- distribution ray tracing (Cook et al., 1984)
  - antialiasing
  - soft shadows
  - depth of field
  - fuzzy reflections
  - motion blur

Transparency and Refraction



[marczych/github]

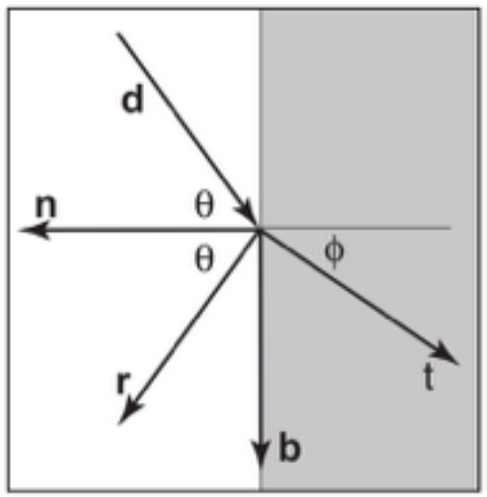
dielectric materials reflect and refract light

Transparency and Refraction

Snell's Law

n1 sinθ= n2 sinϕ

Example values of *n*:
air: 1.00;
water: 1.33–1.34;
window glass: 1.51;
optical glass: 1.49–1.92;
diamond: 2.42.

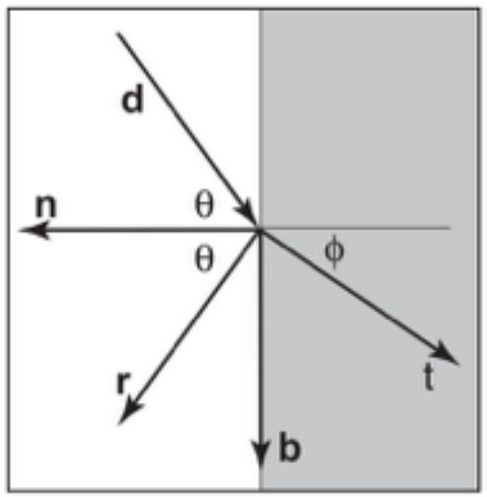


<whiteboard>

Shirley, Peter (2011-12-13).

Transparency and Refraction

Snell's Law



<u>Additional effects</u>

- varying reflectivity

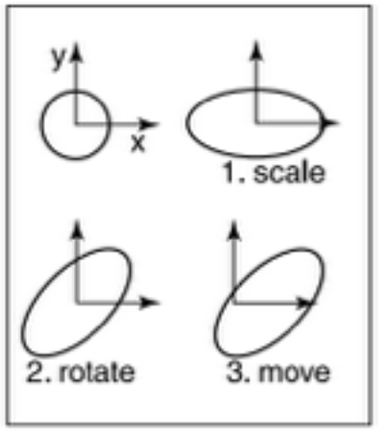
Fresnel equations

- attenuation of light intensity

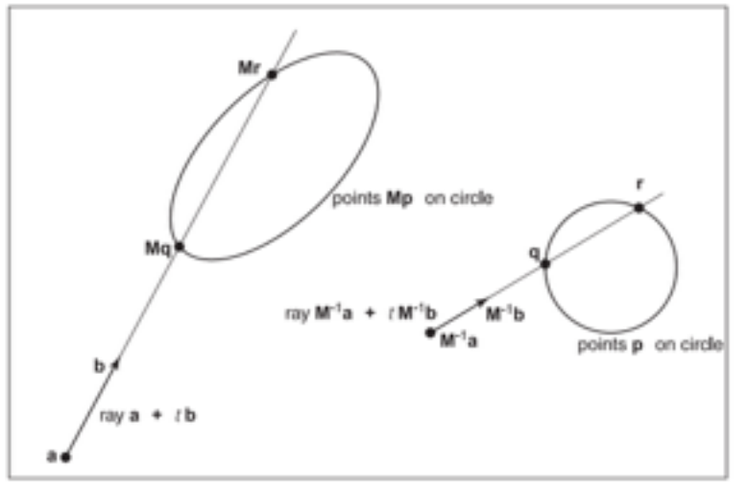
Beer's Law

Shirley, Peter (2011-12-13).
Fresnel equations describe reflectivity - varies with incident angle
Beer's Law - attenuation of light intensity through material

Object Instancing



instance of circle with 3 transformations applied

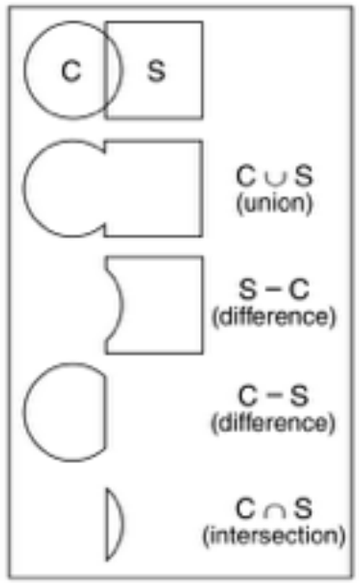


ray intersection problem in the two spaces are simple transforms of each other

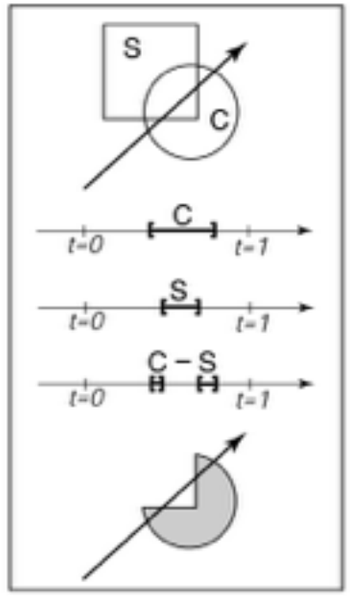
Figure 13.5. The ray intersection problem in the two spaces are just simple transforms of each other. The object is specified as a sphere plus matrix M. The ray is specified in the transformed (world) space by location a and direction b.

Shirley, Peter (2011-12-13). Fundamentals of Computer Graphics (Page 308). Taylor and Francis CRC ebook account. Kindle Edition.

Constructive Solid Geometry (CSG)



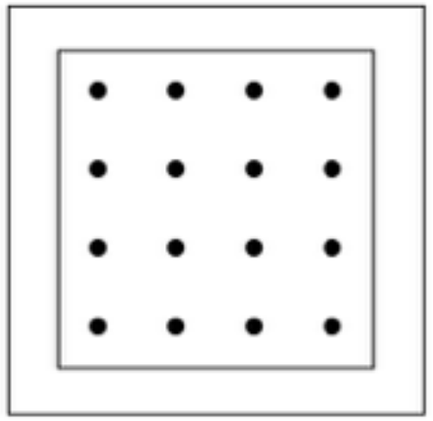
use set operations to combine solid shapes



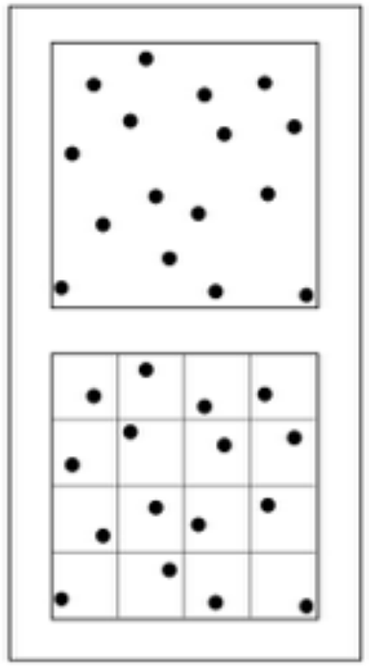
intersection with composite object

Distribution Ray Tracing

Anti-aliasing



16 regular samples / pixel

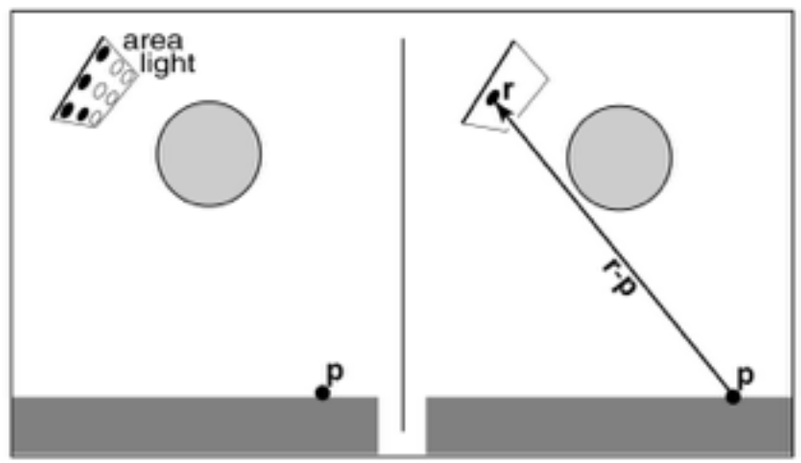


jittered samples

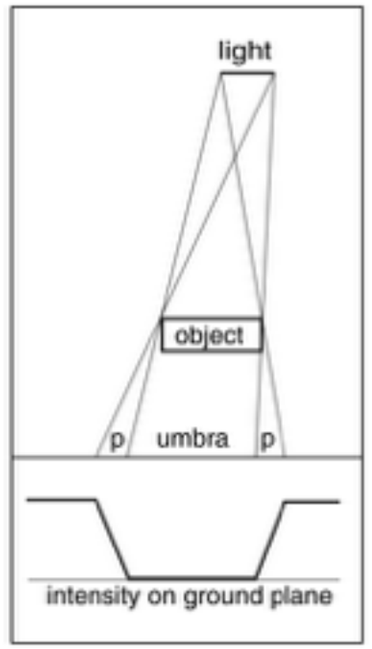
[Shirley and Marschner]

regular samples improve quality but can still result in aliasing artifacts such as moire patterns
jittering the samples alleviates this
- to keep the jittered samples well-distributed over the pixel, sample in 16 bins

Soft Shadows



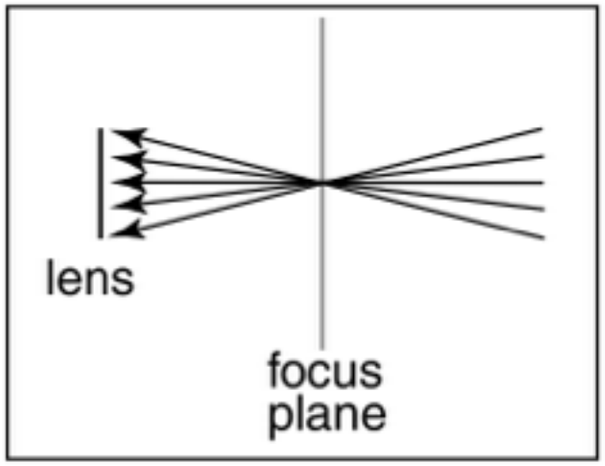
$$\mathbf{r} = \mathbf{c} + \xi_1 \mathbf{a} + \xi_2 \mathbf{b}$$



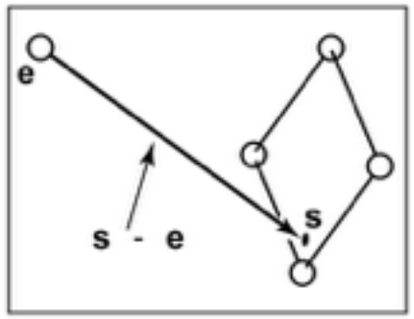
[Shirley and Marschner]

xi random numbers, giving a random sample on the area light

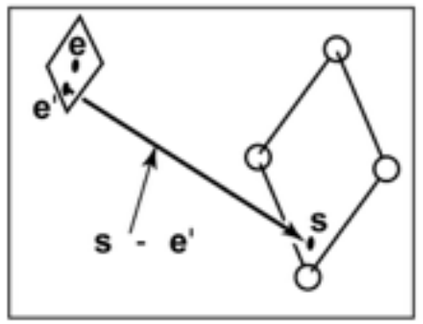
Soft Focus (depth of field)



lens (eye location) averages over a cone of directions



without depth of field



with depth of field

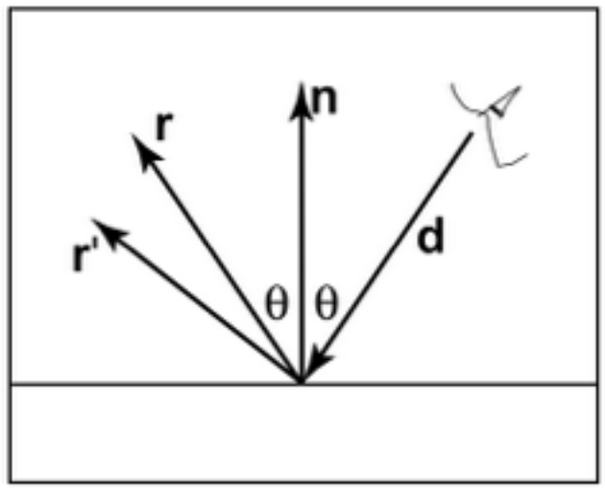
[Shirley and Marschner]

depth of field: collect light at a non-zero size “lens” rather than at a point

Shirley, Peter (2011-12-13). Fundamentals of Computer Graphics (Page 313). Taylor and Francis CRC ebook account. Kindle Edition.

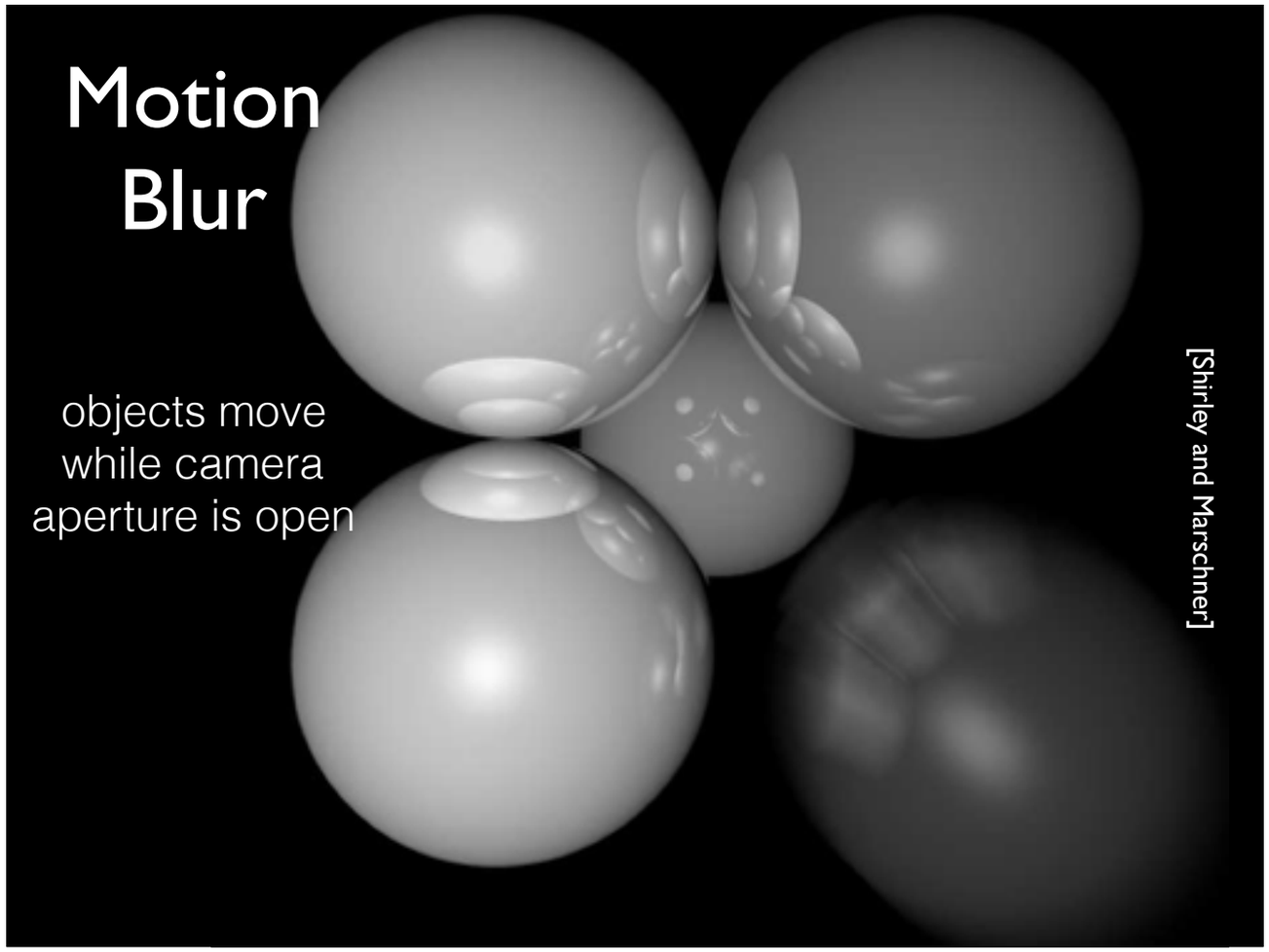

[Shirley and Marschner]

Fuzzy Reflections

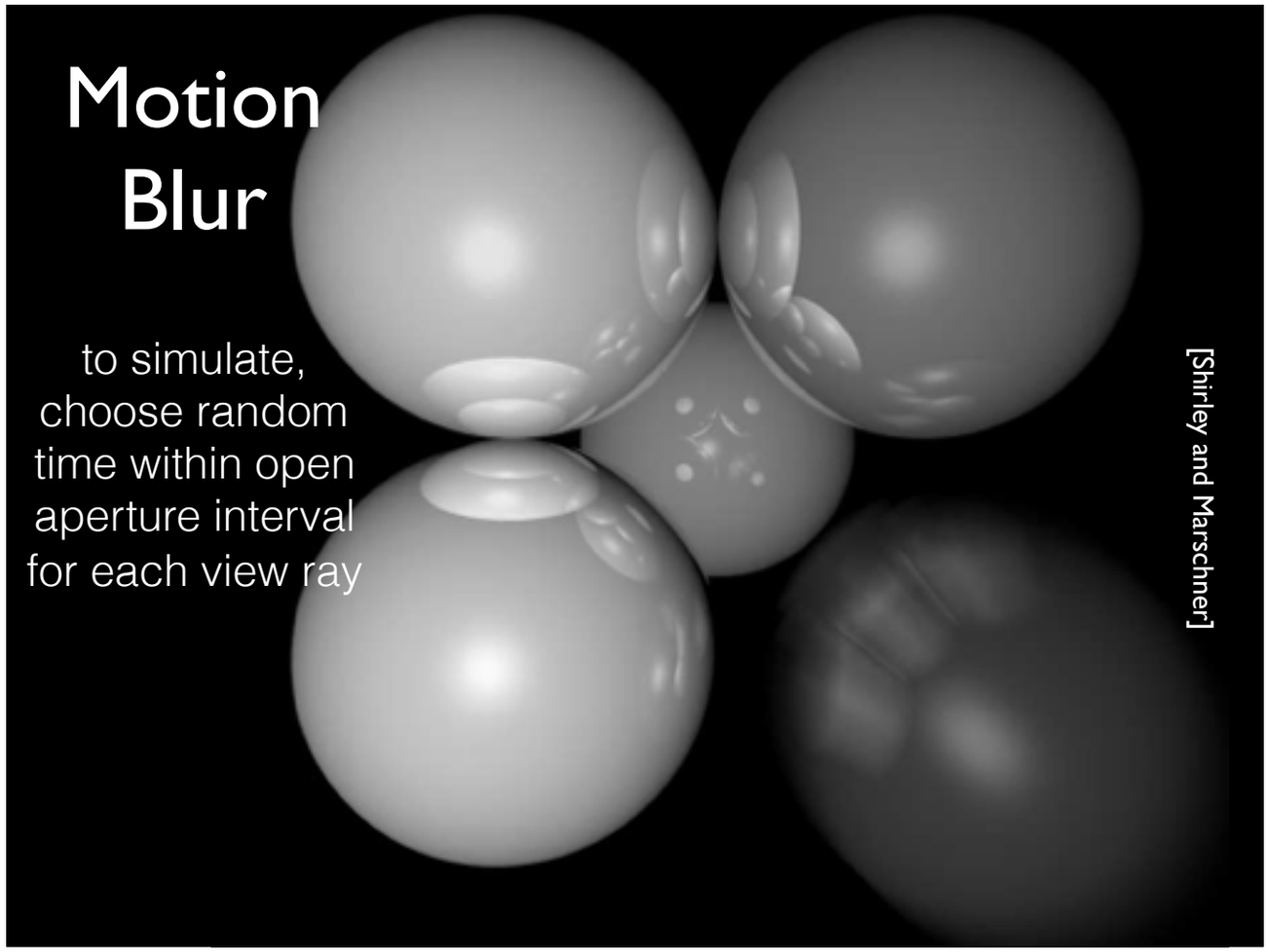


randomly perturb ideal
specular reflection rays

[Shirley and Marschner]



In a real camera, the aperture is open for some time interval during which objects move.



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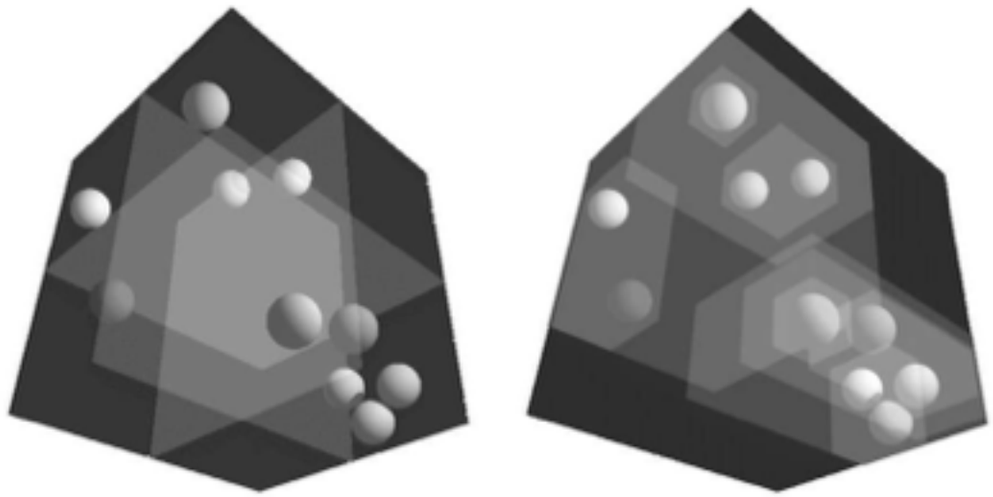
Acceleration Structures

Acceleration Structures



uniform partitioning
of space

adaptive bounding
box hierarchy

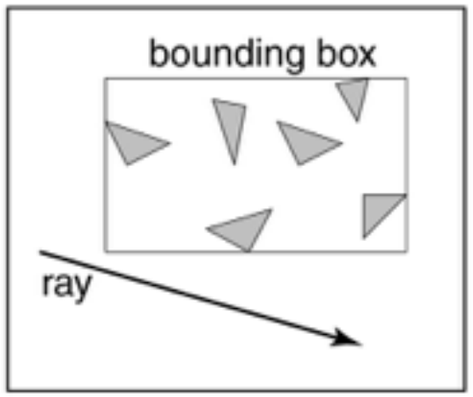
[Shirley and Marschner]

spatial data structures: organize objects in space
so we can quickly locate object in regions of space

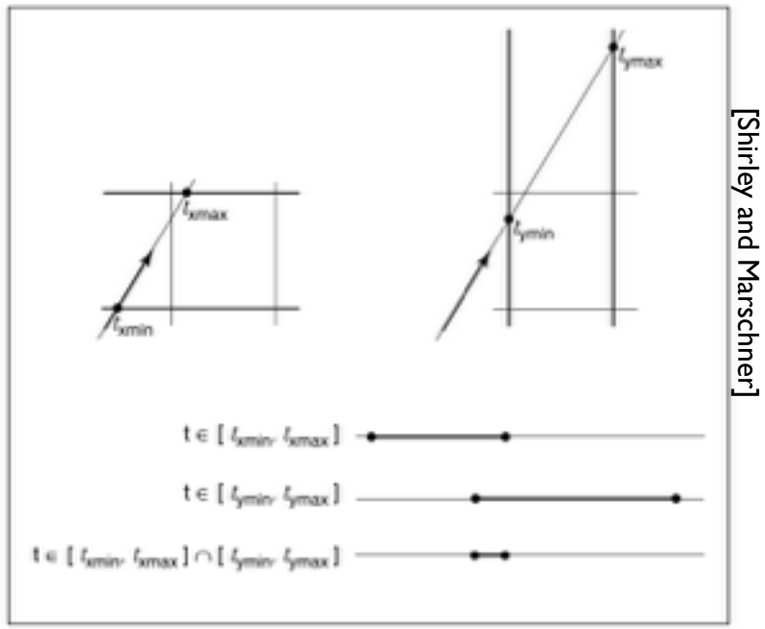
object partitioning
space partitioning

Bounding boxes

key operation in many acceleration schemes



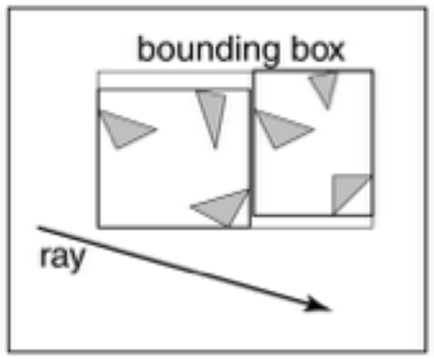
check whether the ray hits the box



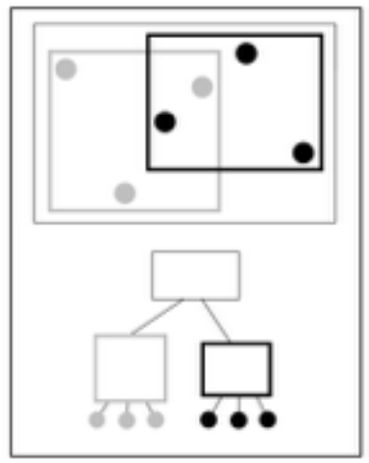
determining if ray hits box

[Shirley and Marschner]

Bounding Volume Hierarchy

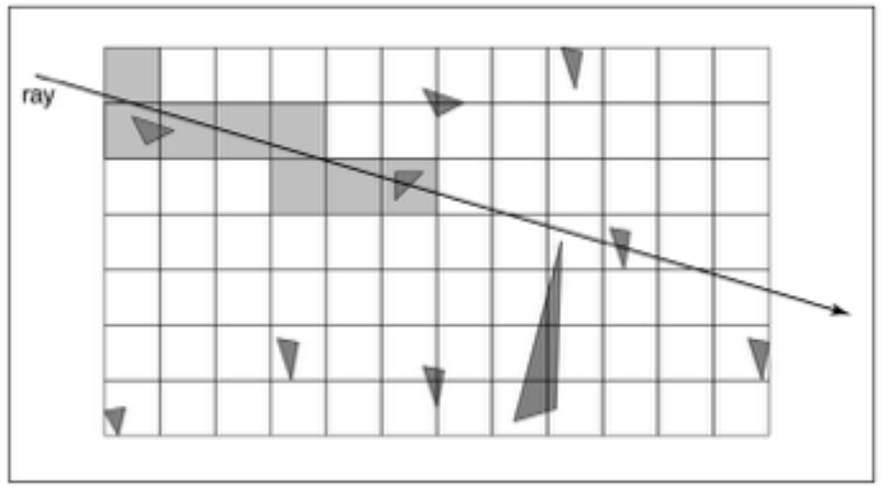


bounding boxes can be nested



[Shirley and Marschner]

Uniform Spatial Partitioning



[Shirley and Marschner]

track a ray forward through cells until an object is hit