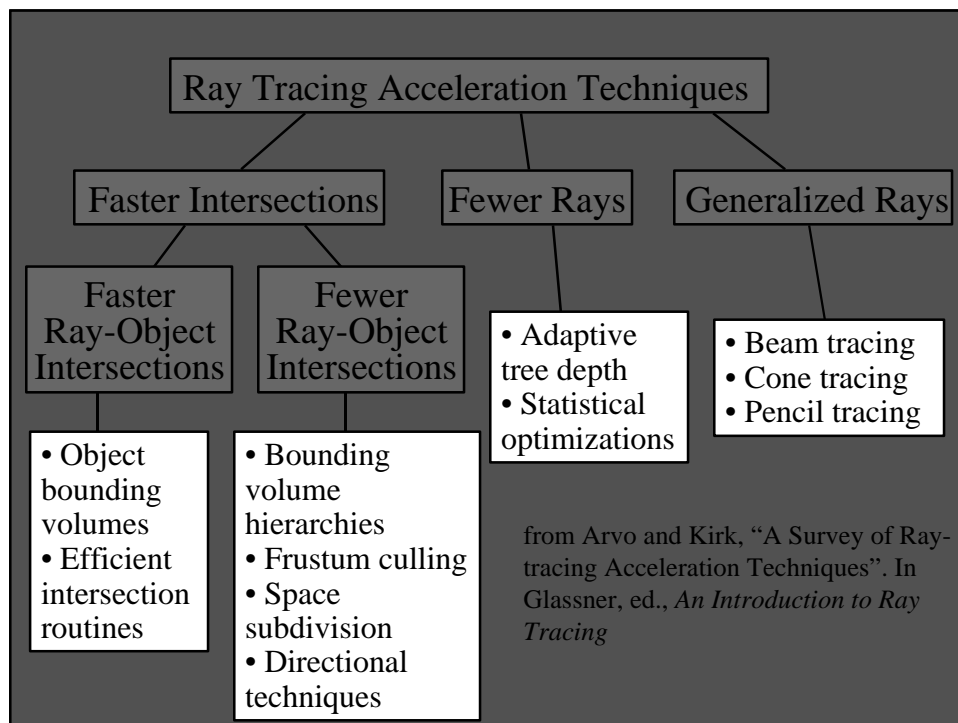




# Accelerating Ray Tracing

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## Bounding Volumes

**Simple volume description guaranteed to contain a more complex volume description**

**Test ray against more complex primitive only if it intersects bounding volume**

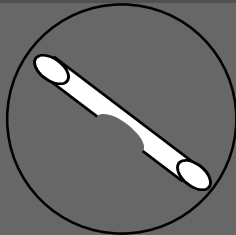
**Increases time for hits, but reduces time when ray misses bounding volume**

**Provide bounds on interval of intersection**

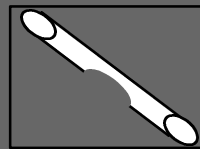
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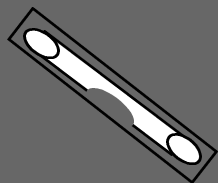
## Bounding Volume Examples



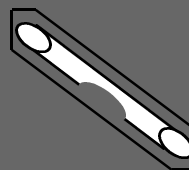
Sphere



Axis-Aligned Bounding Box



Oriented Bounding Box



General Slab Intersection



## Bounding Volume Hierarchies

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**Cluster bounding volumes hierarchically**

**Only intersect ray with child volume if it intersects parent**

**Reduces number of ray-volume and ray-object intersection tests**

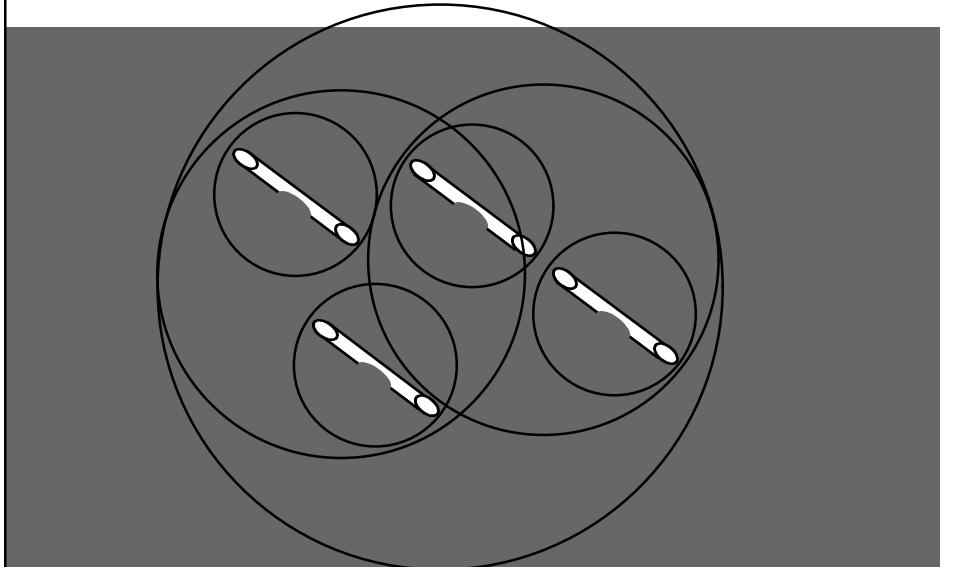
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## Bounding Volume Hierarchy Example

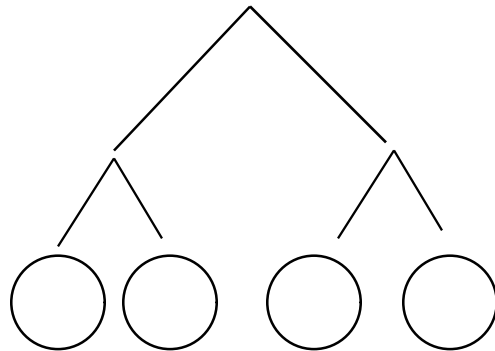
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## Bounding Volume Tree

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## Computing Hierarchies

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**Top-down**

**Bottom-up**

**Minimize volume/surface area**

**Computing “good” hierarchies is difficult**

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## Space Partitioning

**Break model space into chunks**

**Pre-compute which objects overlap each chunk**

**Trace rays through chunks**

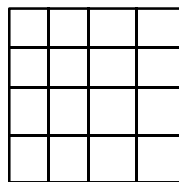
**Only intersect rays with objects stored in current chunk**

**Typically only allow each ray-object intersection once (not in multiple chunks)**

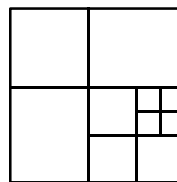
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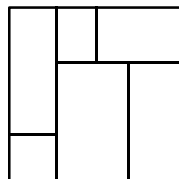
## Types of Space Partitions



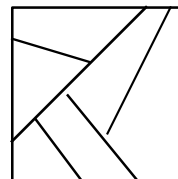
Uniform



Octree



K-d tree



BSP Tree

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## Tracing through a Space Partition

### Incrementally

- trace along ray, walk from partition to partition
- difficult except for uniform partition
- other partitions may require augmented data structures

### Top-down

- intersect ray with each of node's children
- traverse children it intersects

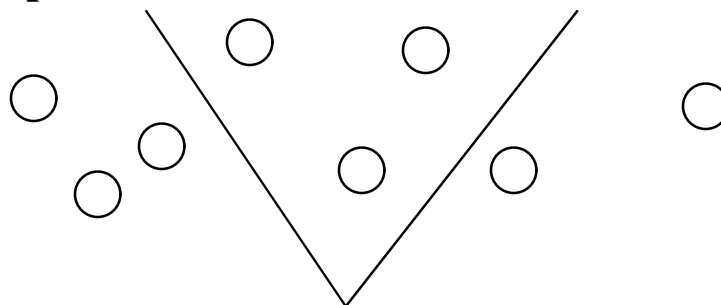
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## Frustum Culling

**Cull all bounding volume nodes that lies outside current viewing frustum**

**Probably not necessary if using space partition**



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## Frameless Rendering

**Double buffering - wait for all pixels to display image**

- Slowly displays old images

**Frameless rendering - display all pixels immediately**

- Quickly displays partially-updated images

**Applicable to interactive applications requiring low latency and high performance**

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## Frameless Rendering Example



**All pixels updated at 5 Hz**



**33% pixels updated at 15 Hz**

From Bishop et al., "Frameless Rendering: Double Buffering Considered Harmful,"  
*Proceedings of SIGGRAPH 94*, page 176.

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## Interactive Ray Tracing

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### Experiments run on high-end parallel machine

- Scales to hundreds of processors on SGI Origin 2000
- Scalability limited only by load balancing and synchronization

### Can employ frameless rendering

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## Interactive Ray Tracing Video

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From Parker et al., “Interactive Ray Tracing,” *Proceedings of the 1999 Symposium on Interactive 3D Graphics*”.

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## Questions about Assignment?

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### **Input colors [0.0-1.0]**

- **Output colors [0-255]**

### **Eye space**

- **Looking down -Z axis**

### **Viewing plane**

- **Distance is irrelevant**

### **File format**

- **Assume lines not broken up**
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