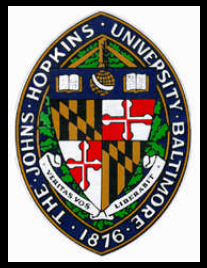
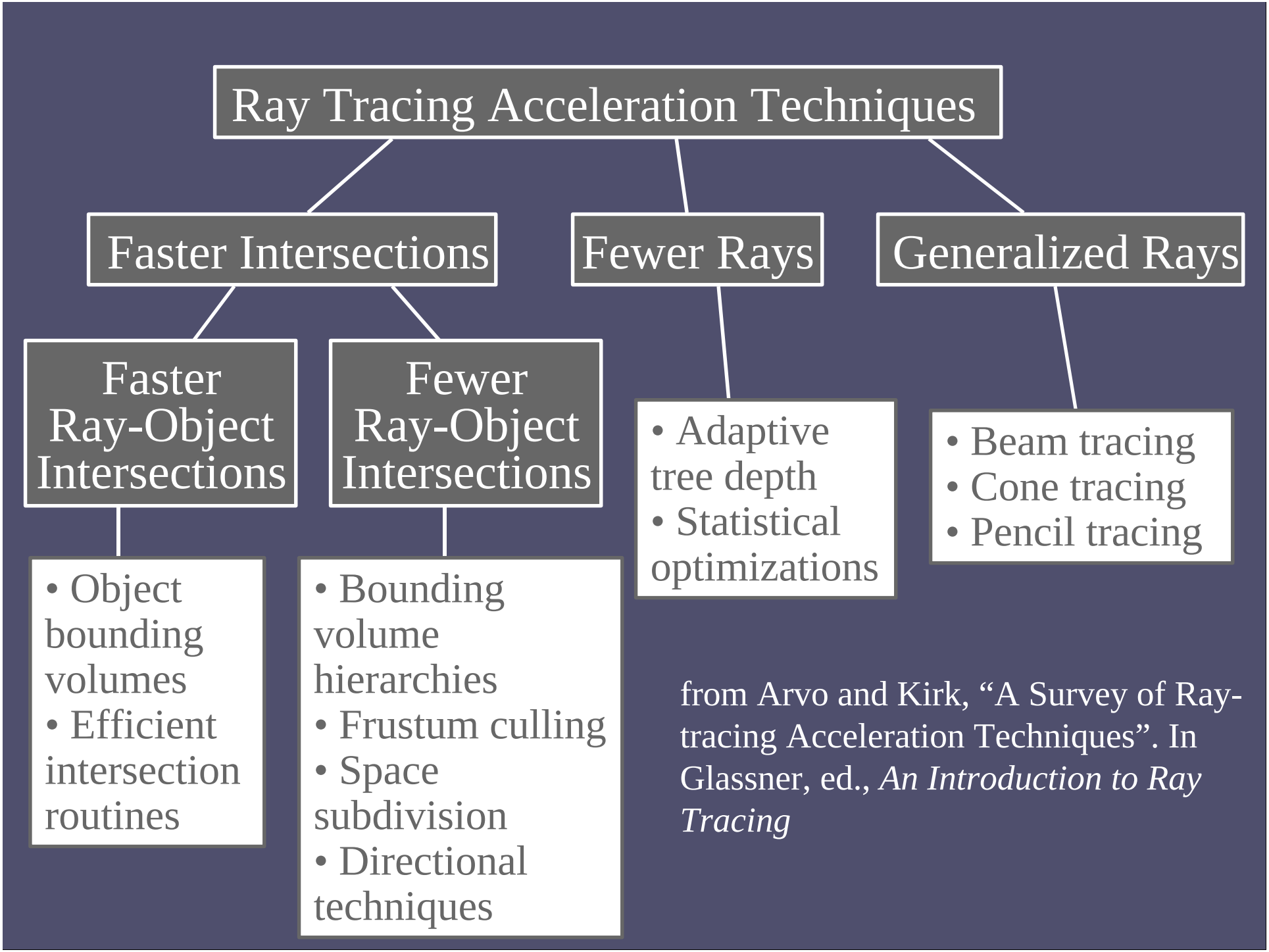
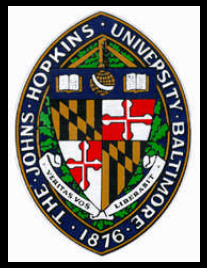


Accelerating Ray Tracing

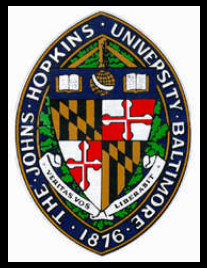


from Arvo and Kirk, “A Survey of Ray-tracing Acceleration Techniques”. In Glassner, ed., *An Introduction to Ray Tracing*



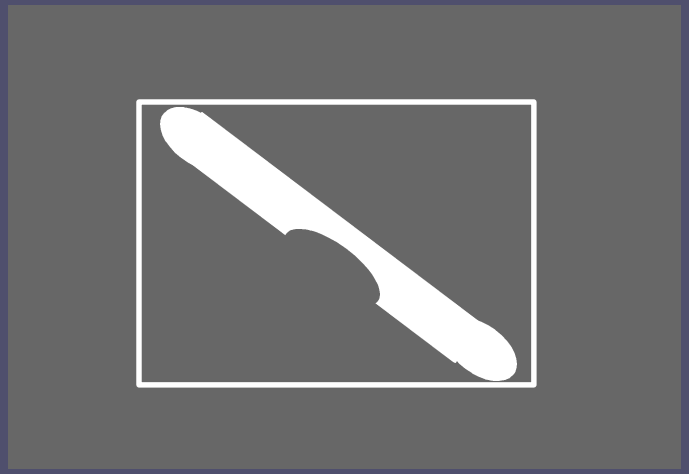
Bounding Volumes

- 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

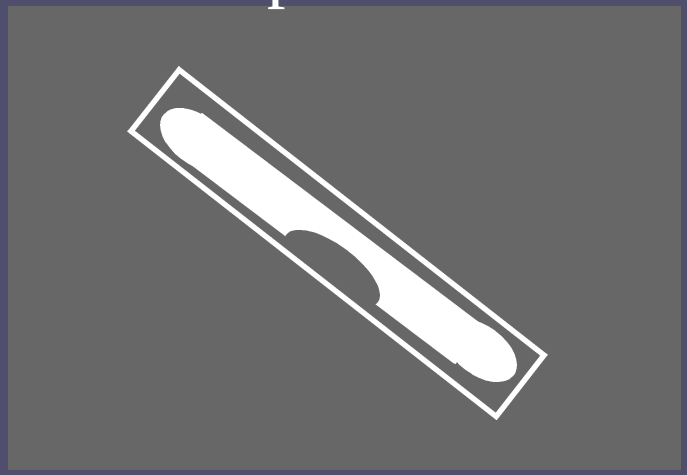


Bounding Volume Examples

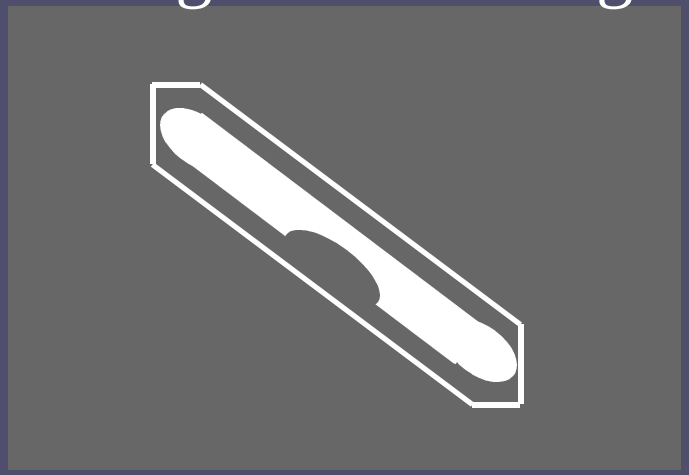
Sphere



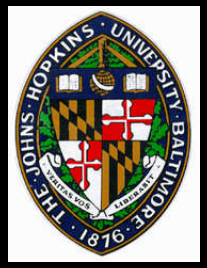
Axis-Aligned Bounding Box



Oriented Bounding Box



General Slab Intersection

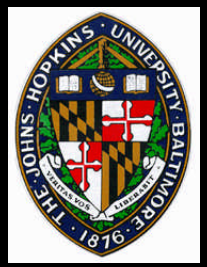


Bounding Volume Hierarchies

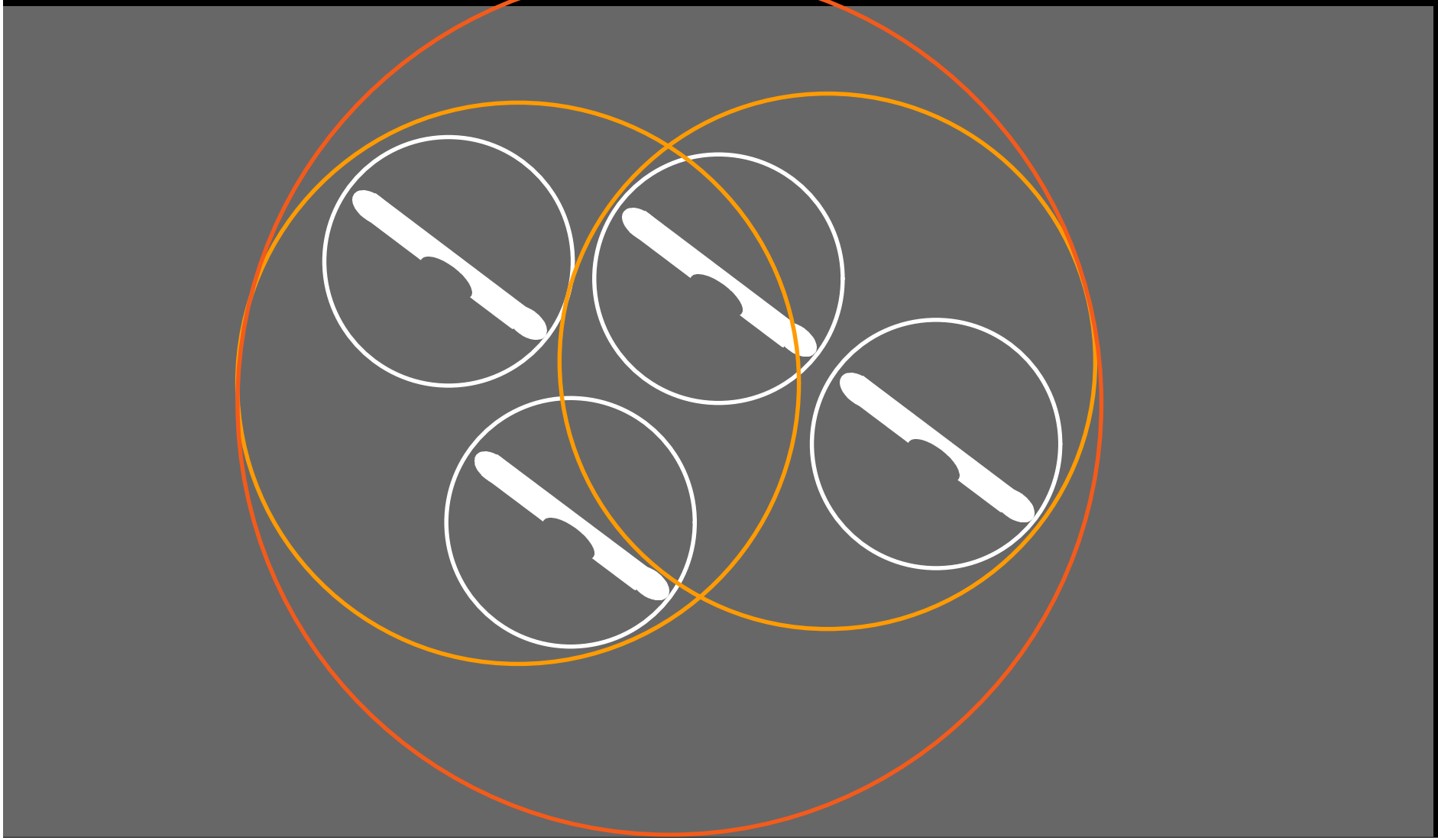
Cluster bounding volumes hierarchically

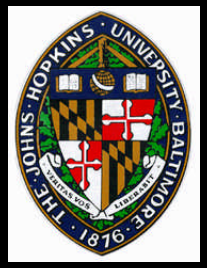
Only intersect ray with child volume if it intersects parent

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

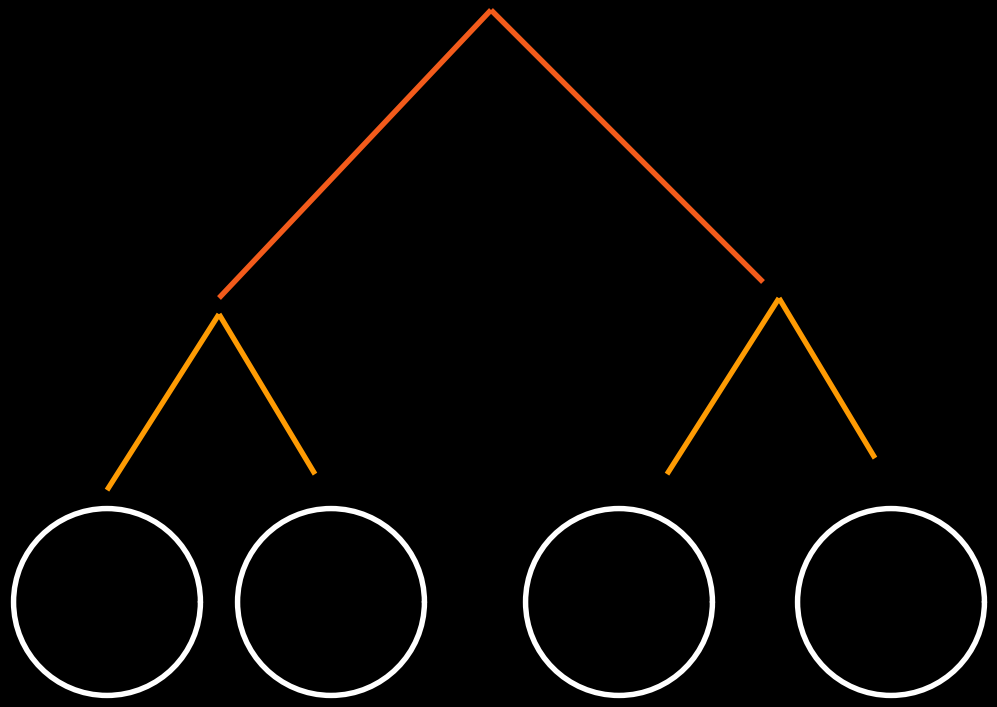


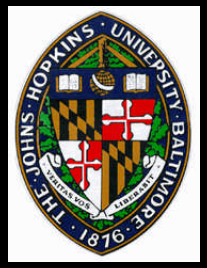
Bounding Volume Hierarchy Example





Bounding Volume Tree





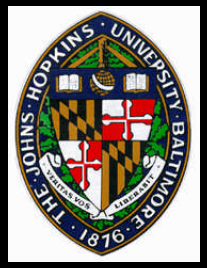
Computing Hierarchies

Top-down

Bottom-up

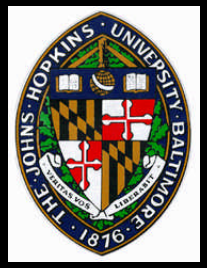
Minimize volume/surface area

Computing “good” hierarchies is difficult

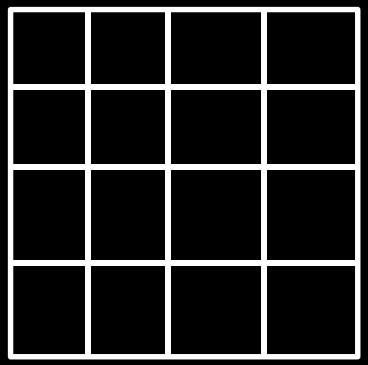


Space Partitioning

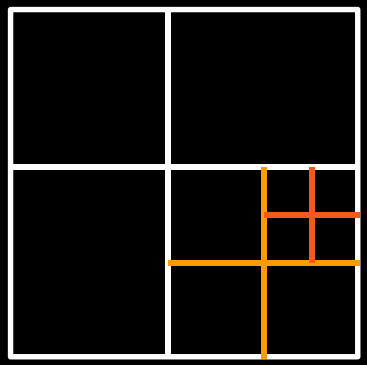
- Break model space into chunks
- Pre-compute which objects overlap each chunk
- Trace rays through chunks
- Only intersect rays with objects stored in current chunk
- Typically only allow each ray-object intersection once (not in multiple chunks)



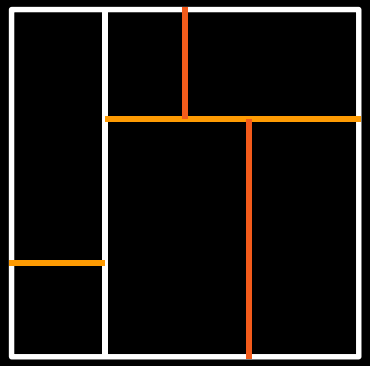
Types of Space Partitions



Uniform

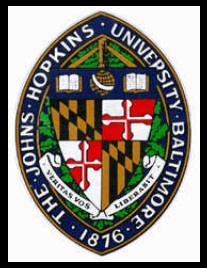


Octree



K-d tree

BSP Tree



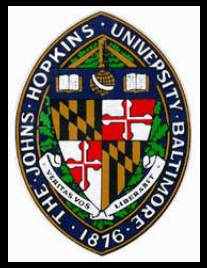
Tracing through a Space Partition

Incrementally

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

Top-down

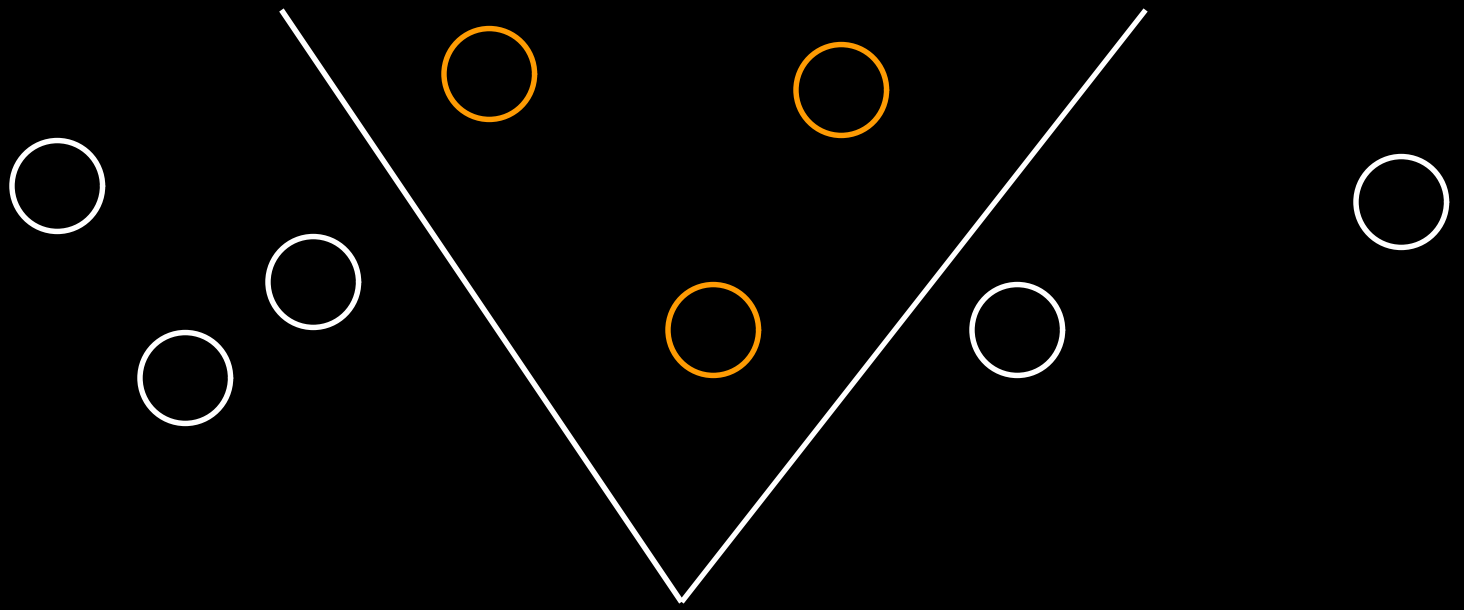
- intersect ray with each of node's children
- traverse children it intersects

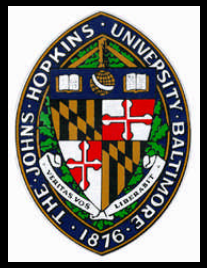


Frustum Culling

Cull all bounding volume nodes that lies outside current viewing frustum

Probably not necessary if using space partition





Frameless Rendering

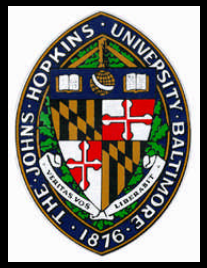
Double buffering - wait for all pixels to display image

- **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

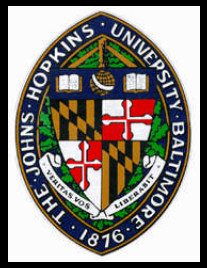


Frameless Rendering Example

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.

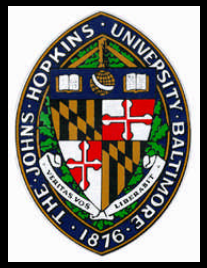


Interactive Ray Tracing

Experiments run on high-end parallel machine

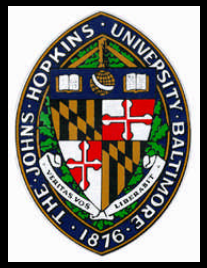
- **Scales to hundreds of processors on SGI Origin 2000**
- **Scalability limited only by load balancing and synchronization**

Can employ frameless rendering



Interactive Ray Tracing Video

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



Questions about Assignment?

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**