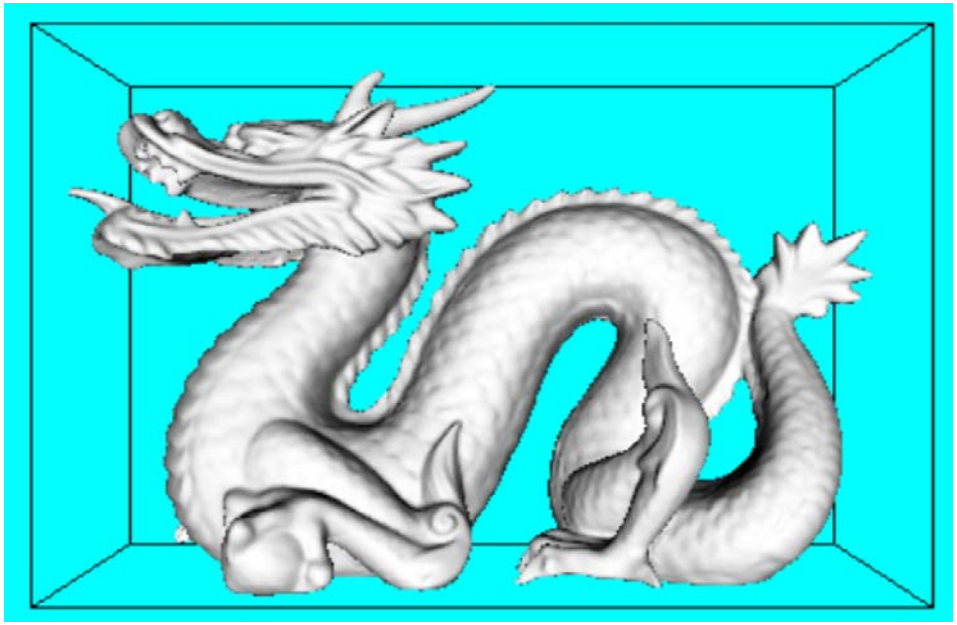
Bounding Volumes

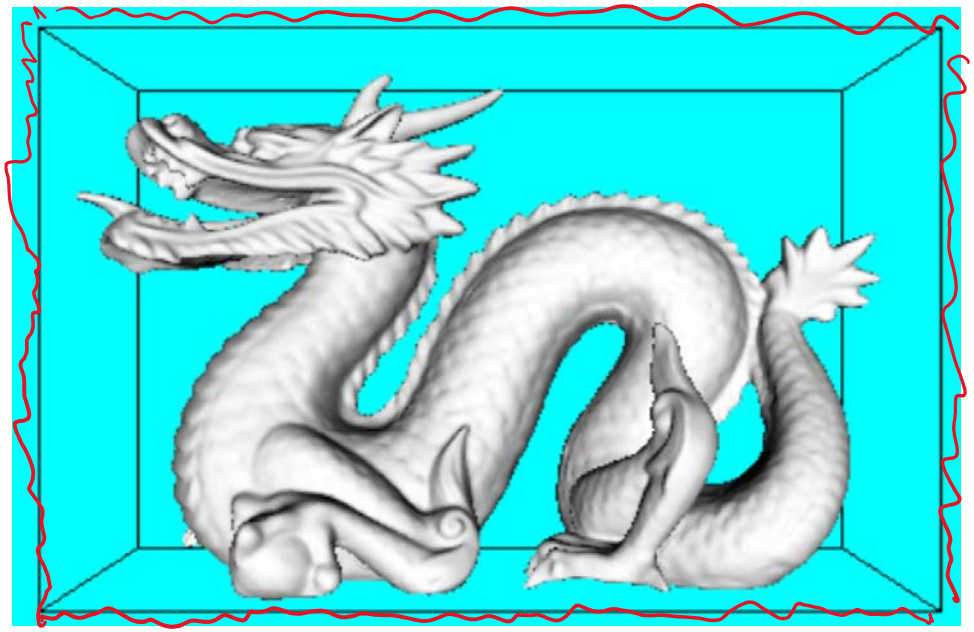


Ray Tracing
Ray-intersection tests
Millions of triangles vs bounding volume

Left: Bounding box

Considerations
Cost of ray-bounding volume intersection
Amount of void space

Bounding Volumes



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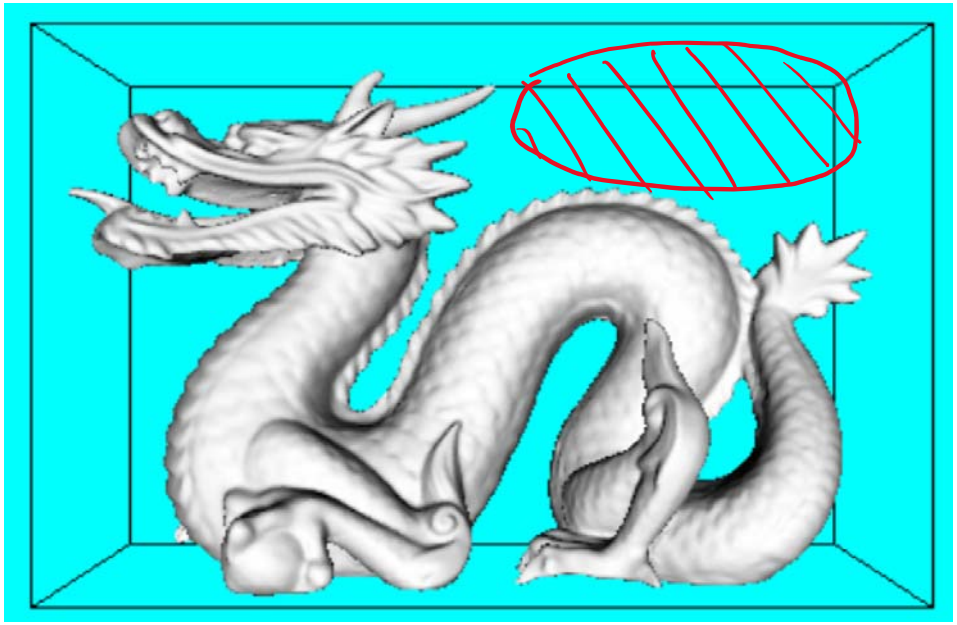

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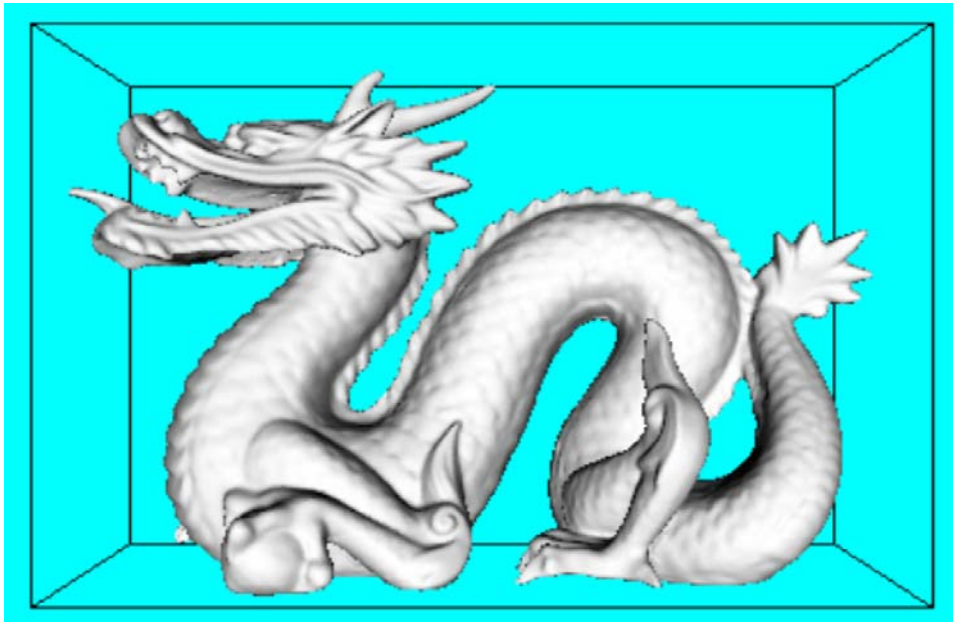

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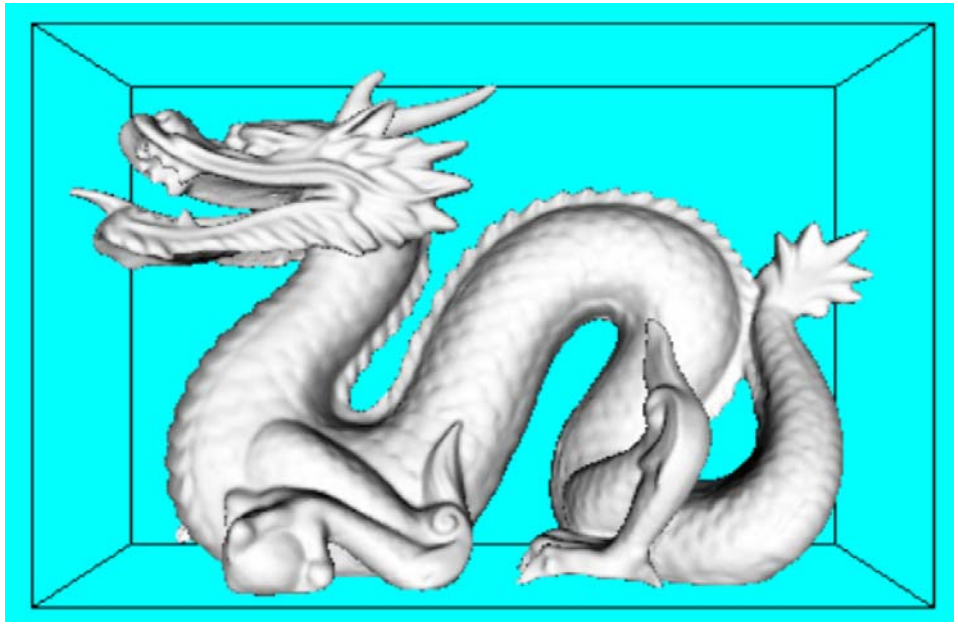
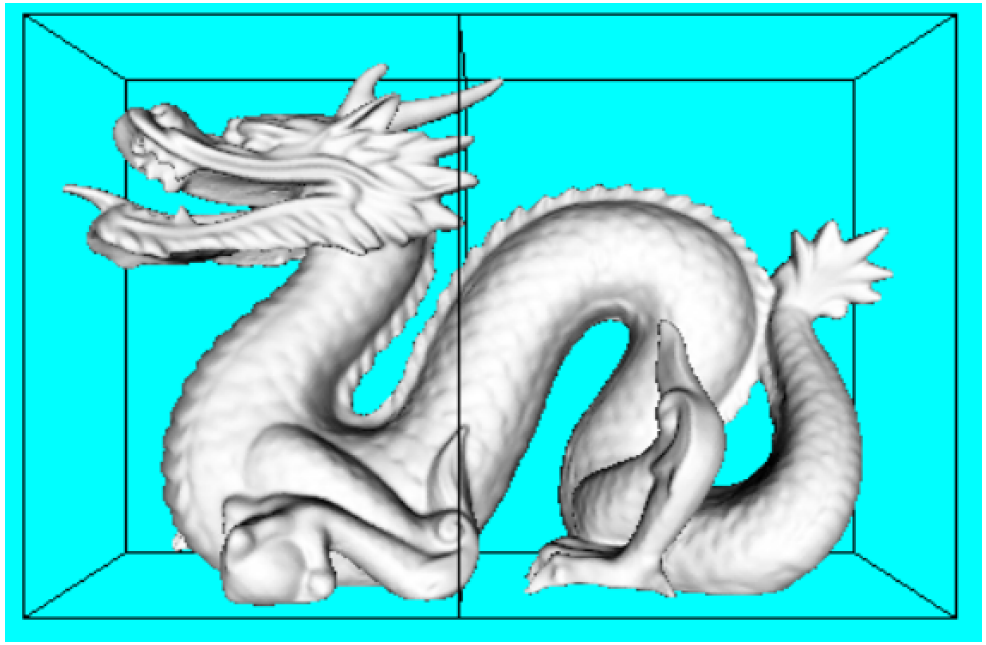


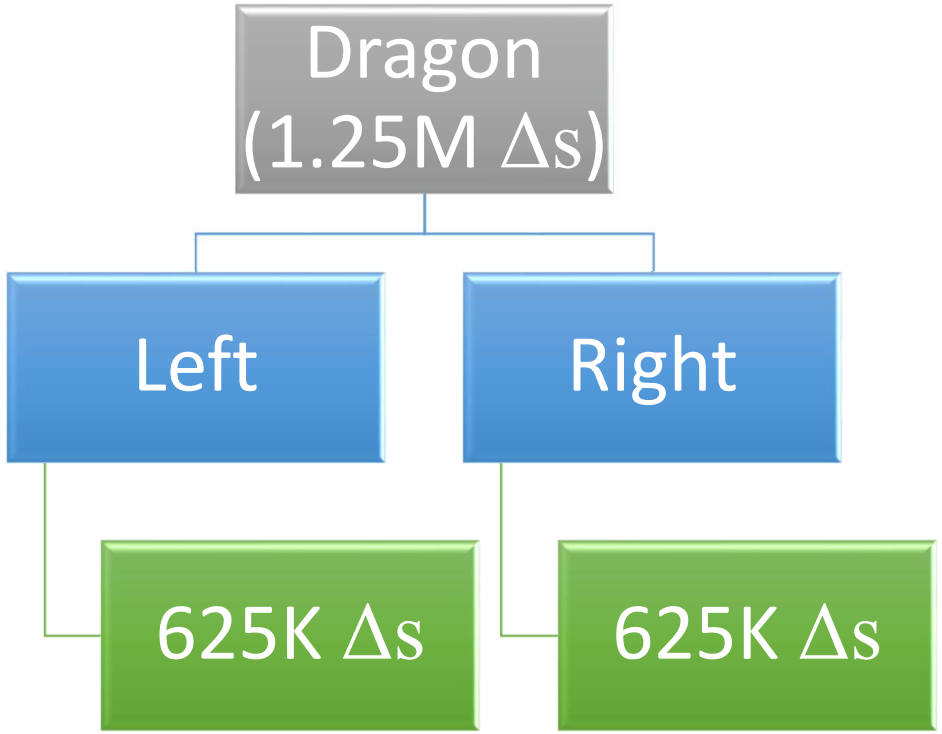
1,000x1000 pixels
Assume 5% rays miss bounding volume
95% rays hit volume and must be tested against 1.25 million triangles

50,000 rays need 1 AABB test
950,000 rays need 1 AABB test and 1.25M ray-triangle tests

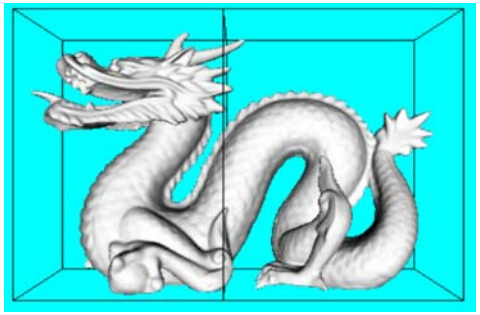
We improved the speed slightly (around 4-5%)

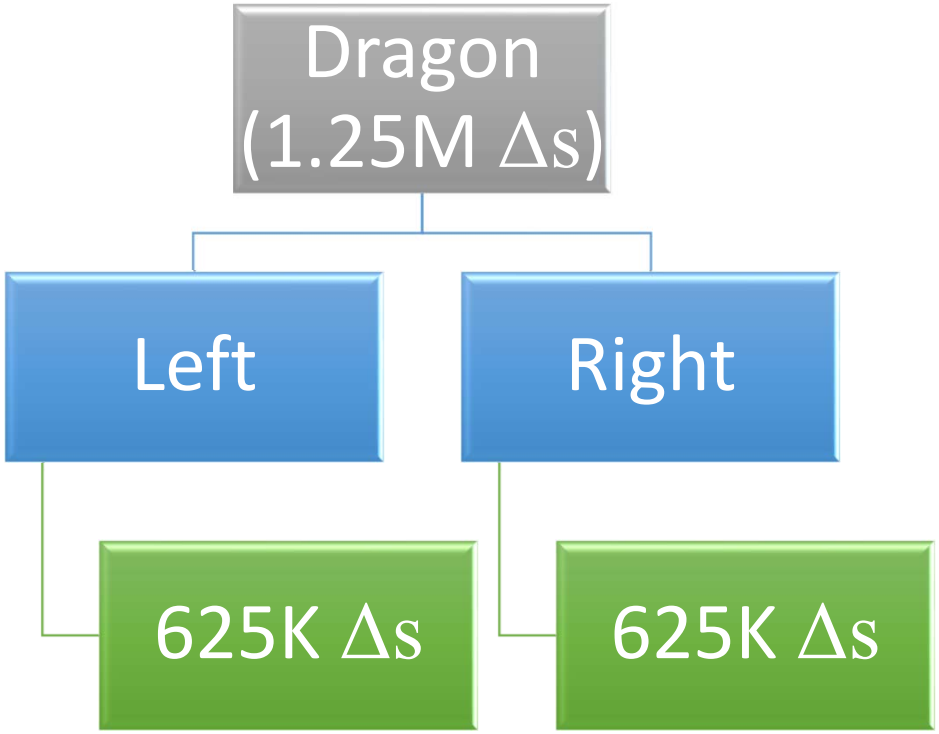
Bounding Volume Hierarchy





Bounding Volume Hierarchy





Root:
Ray misses bounding volume (stop) OR
Hits bounding volume

Hit left or right node?
Left: Test against those 625K triangles
Right: Test against those 625K triangles

Bounding Volumes

1,000x1000 pixels
Assume 5% rays miss bounding volume
95% rays hit volume and must be tested against 1.25 million triangles

50,000 rays need 1 AABB test
950,000 rays need 1 AABB test and
1.25M ray-triangle tests

We improved the speed slightly (around 4-5%)

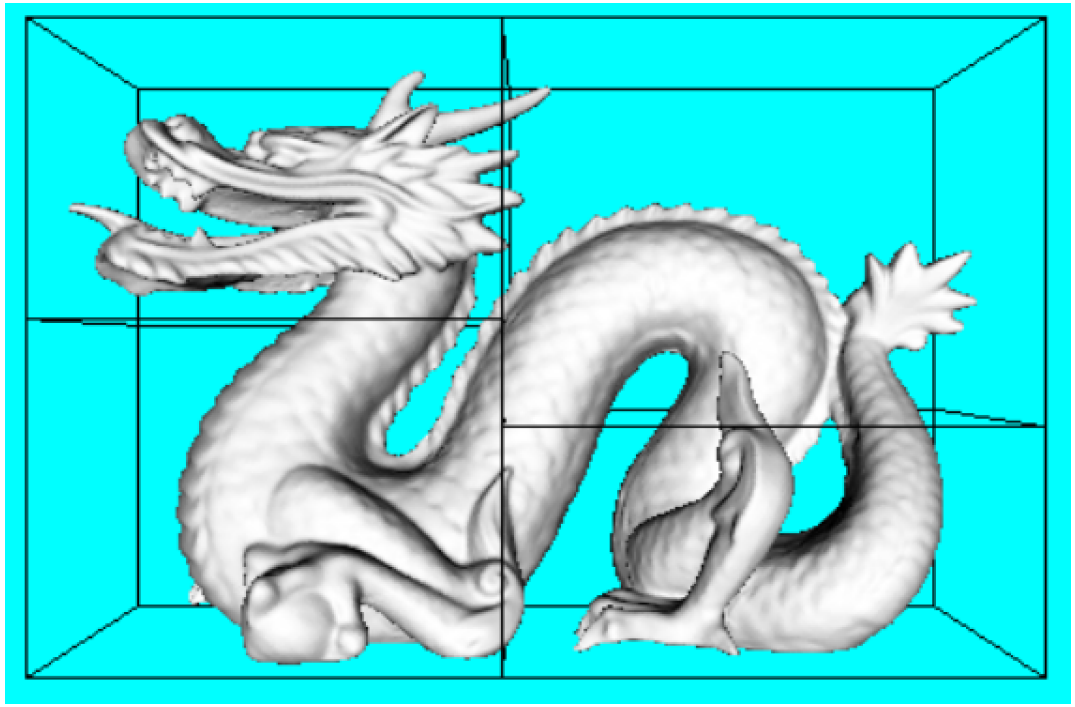
1,000x1000 pixels
Assume 5% rays miss bounding volume
95% rays hit volume and must be tested against 2 bounding volumes

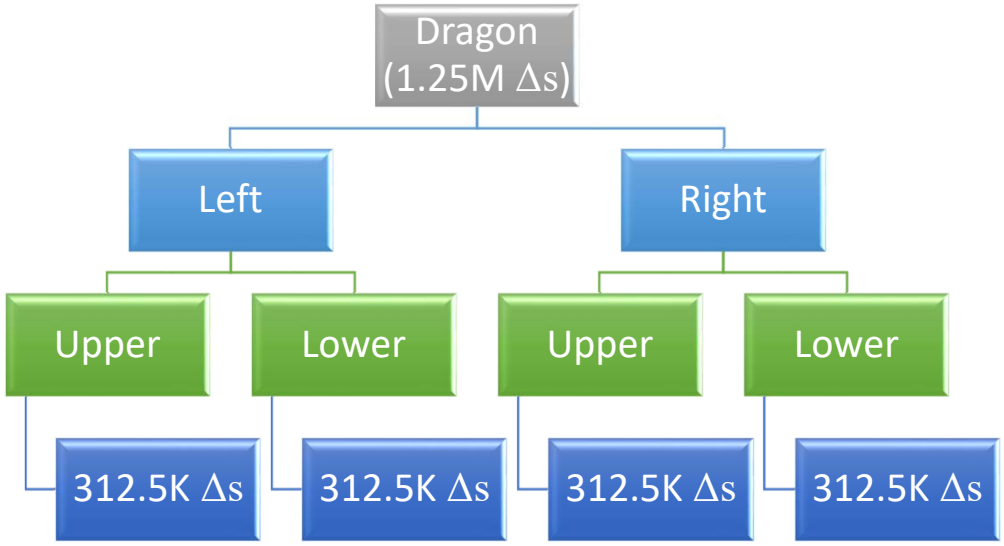
47.5% rays hit left and must be tested against 625K triangles.
47.5% hit right.

50,000 rays need 1 AABB test
950,000 rays need 3 AABB tests and
625K ray-triangle tests

We improved the speed significantly (around 50%)

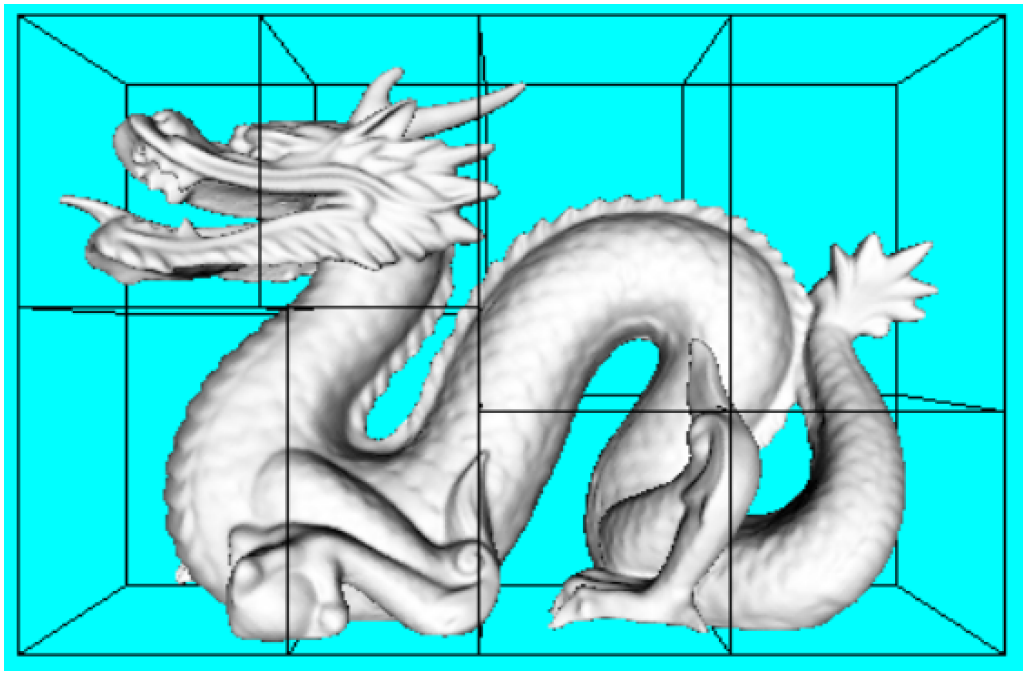
Bounding Volume Hierarchy

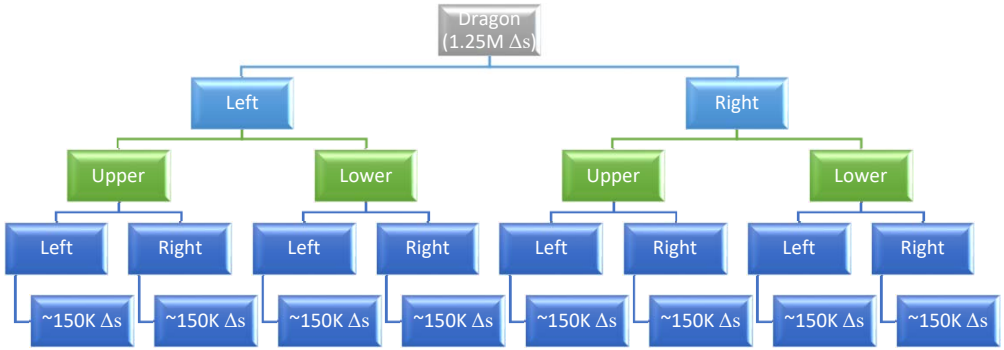




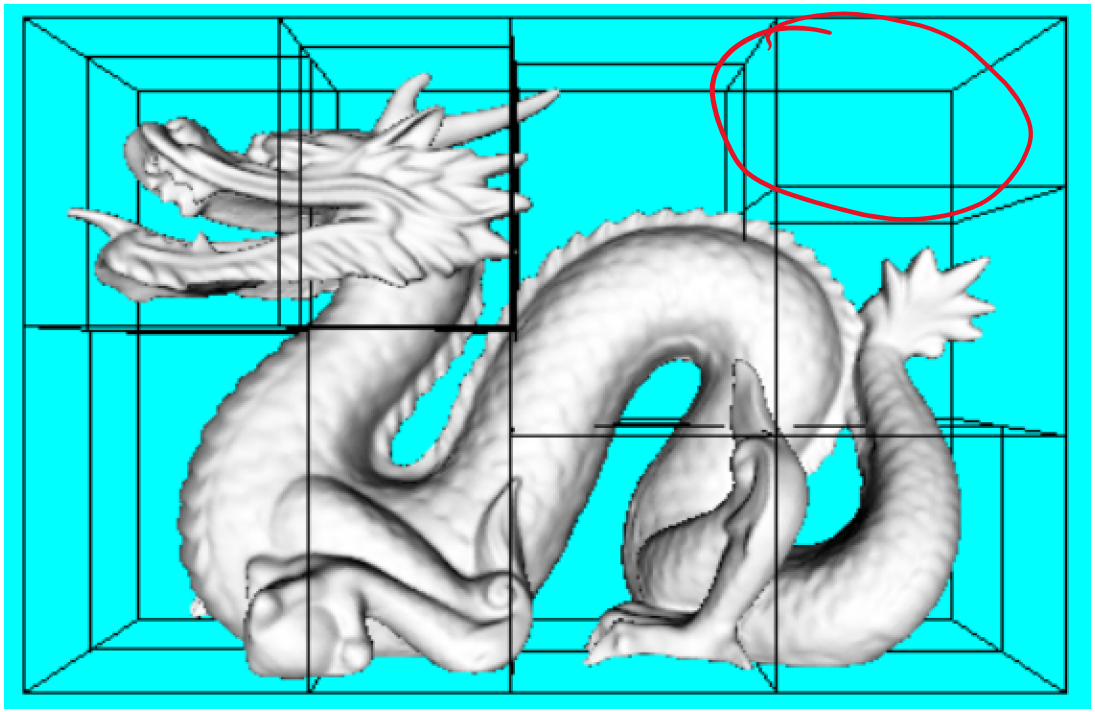
Note: We are simplifying things. More on this later

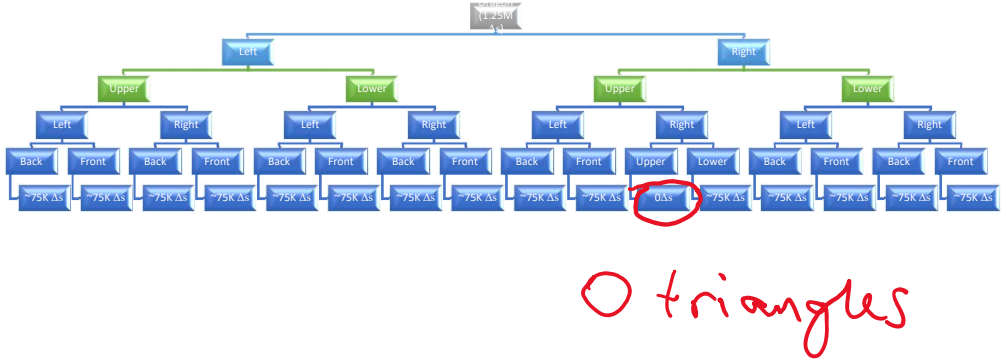
Bounding Volume Hierarchy





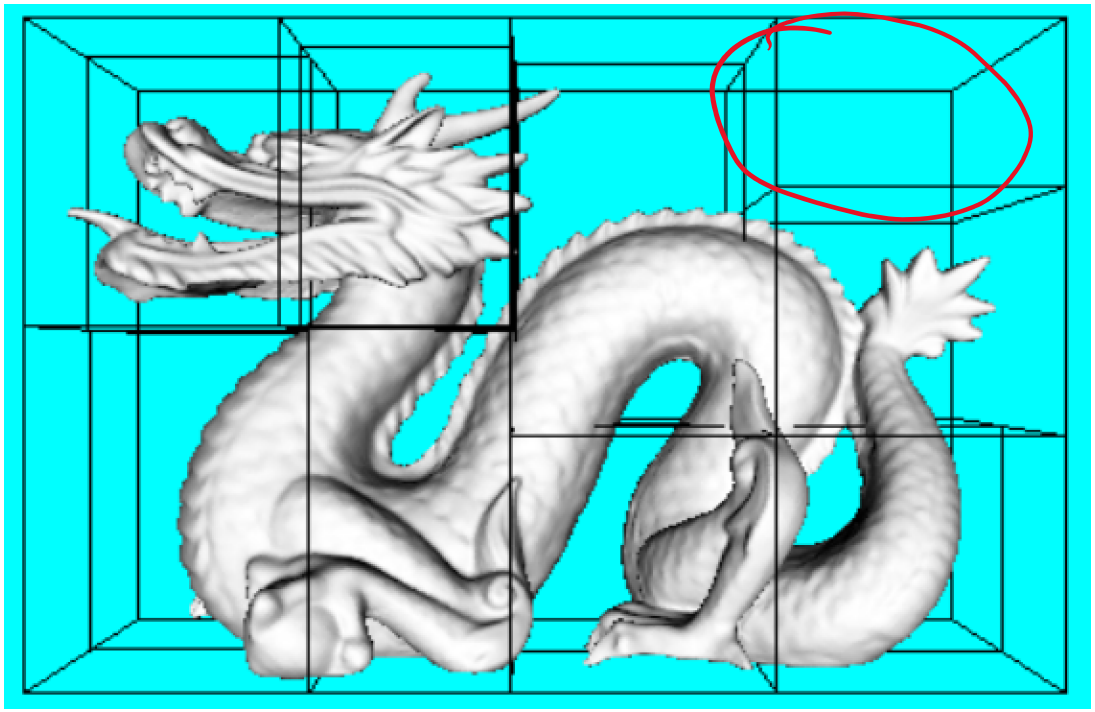
Bounding Volume Hierarchy

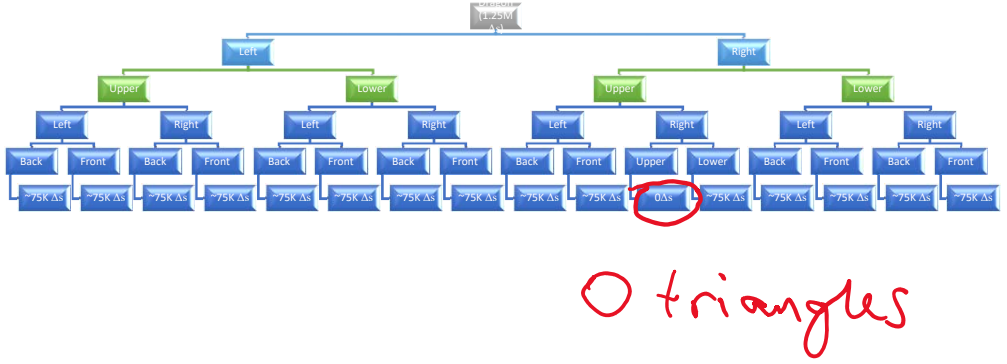




0 triangles

Bounding Volume Hierarchy





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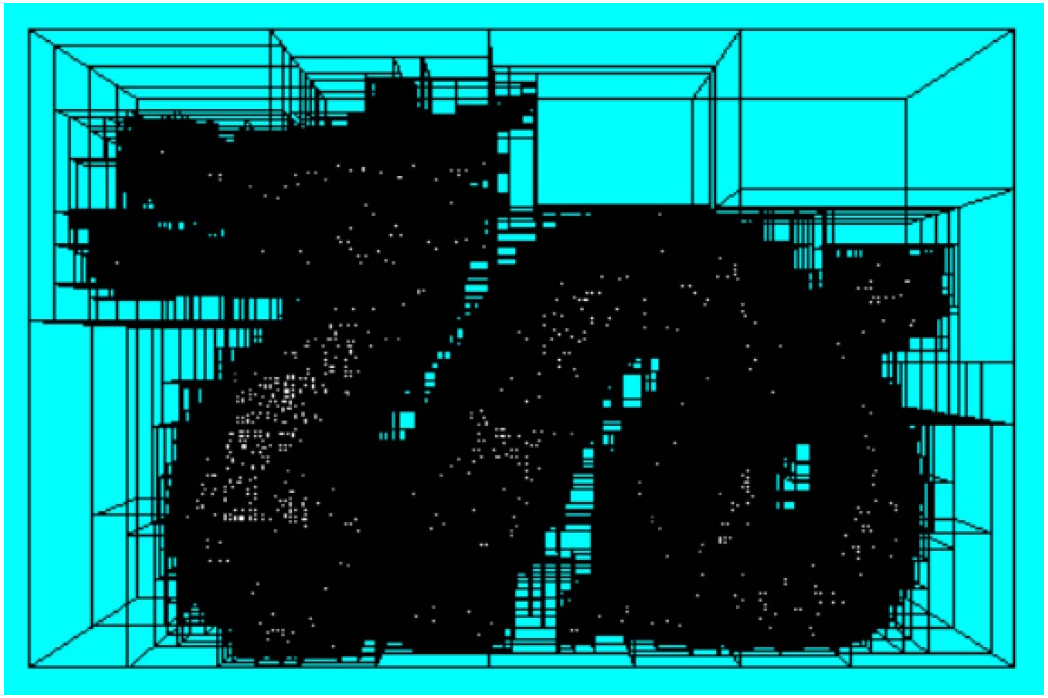
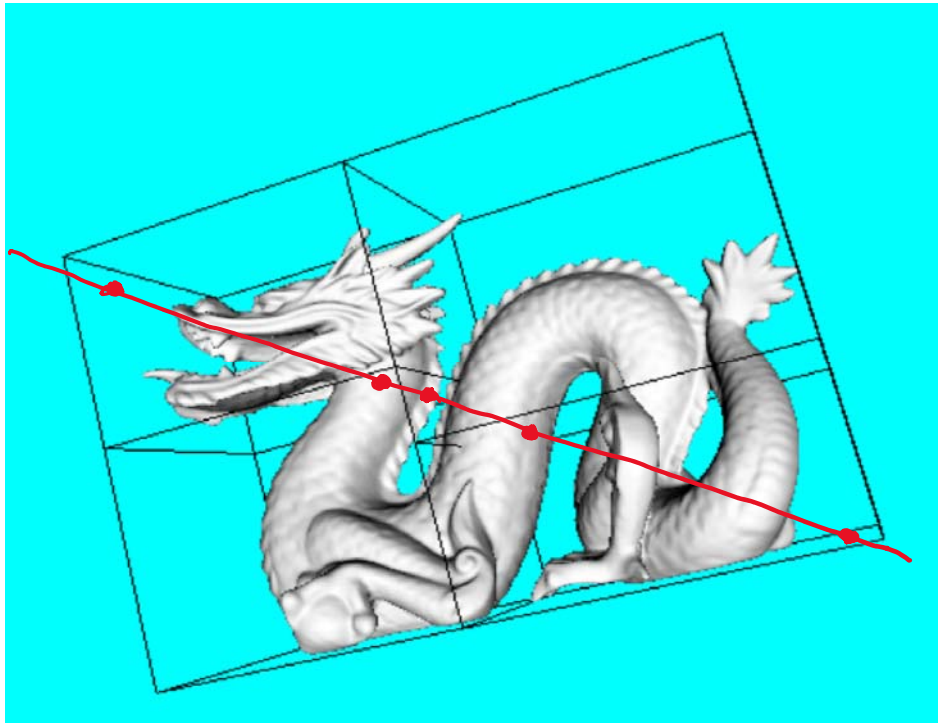


Build process
Find splitting plane
Move triangles to appropriate sub-tree
Recurse until:
(i) We reach the maximum depth OR
(ii) We get less than a desired number of triangles in the node.

This tree:
Maximum depth: 25
Target triangles per node:3

Actual triangles per node: 2.14 average

Bounding Volume Hierarchy



More details to consider:

Triangles not split evenly between children
Split could go through a triangle
Rays could hit more than one bounding volume

Algorithm/implementation must address all situations