CS 6958
LECTURE 9
BVH

February 5, 2014
Axis Aligned Bounding Box

- Let’s try to derive an intersection test
- Box representation?
Let’s try to derive an intersection test

Box representation?
- 12 triangles?
- 6 planes with limits?
- Min/max points?
Ray-Plane intersection

- Plane equation: $N \cdot P - d = 0$
- Hit-point: $t = \frac{d - N \cdot O}{N \cdot V}$
Axis Aligned Bounding Box

Consider x direction only

\[
N = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}
\]

\[
t = \frac{d - O_x}{V_x}
\]

\[
d_1 = P_{1x}, d_2 = P_{2x}
\]

\[
t_{x1} = \frac{P_{1x} - O_x}{V_x}, t_{x2} = \frac{P_{2x} - O_x}{V_x}
\]
AABB - Intervals

intersection occurs when x interval overlaps y interval

\[ x: \min(t_{x1}, t_{x2}) \leq t \leq \max(t_{x1}, t_{x2}) \]
\[ y: \min(t_{y1}, t_{y2}) \leq t \leq \max(t_{y1}, t_{y2}) \]

intersection

\[ \max(\min_x, \min_y) \leq t \leq \min(\max_x, \max_y) \]
better intersection:
http://www.cs.utah.edu/~awilliam/box

<table>
<thead>
<tr>
<th>Operation</th>
<th>add / sub / mult</th>
<th>compare</th>
<th>divide</th>
</tr>
</thead>
<tbody>
<tr>
<td>AABB</td>
<td>8 / 12 / 12</td>
<td>4 / 9 / 13</td>
<td>2 / 3 / 3</td>
</tr>
<tr>
<td>AABB, optimized</td>
<td>8 / 12 / 12</td>
<td>(3 pre) 2 / 4 / 10</td>
<td>(3 pre) 0</td>
</tr>
<tr>
<td>Triangle, Barycentric coords</td>
<td>20 / 29 / 45 / 51</td>
<td>2 / 4 / 6 / 8</td>
<td>0 / 1 / 1 / 1</td>
</tr>
</tbody>
</table>
Next

- Using TRaX main memory
  - loading triangles, BVH nodes
  - traversing BVH in more detail