CS-184: Computer Graphics

Lecture #7: BSP and AABB Trees

Prof. James O'Brien
University of California, Berkeley

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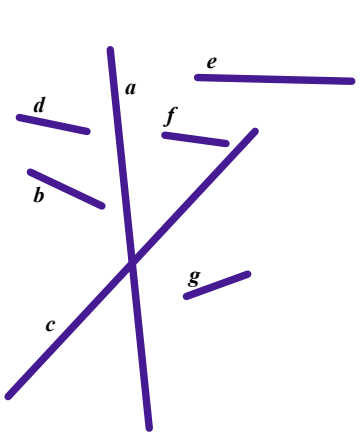
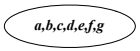
BSP-Trees

- Binary Space Partition Trees
  - Split space along planes
  - Allows fast queries of some spatial relations
- Simple construction algorithm
  - Select a plane as sub-tree root
  - Everything on one side to one child
  - Everything on the other side to other child
  - Use random polygon for splitting plane

BSP-Trees





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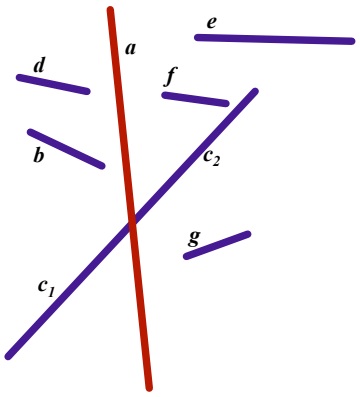

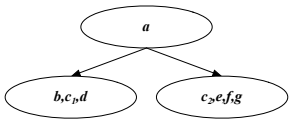

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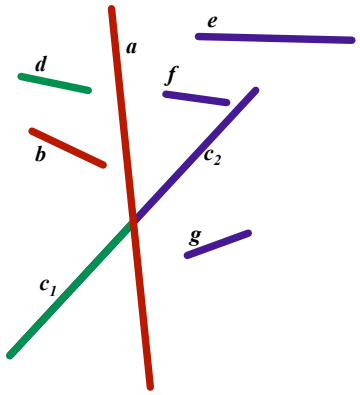

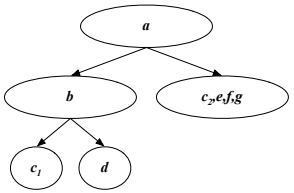

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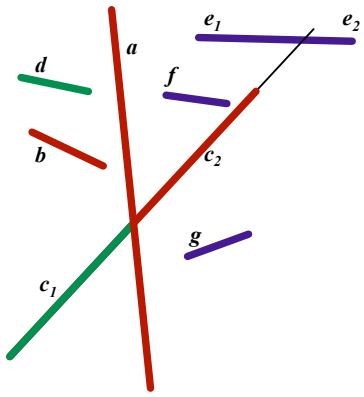

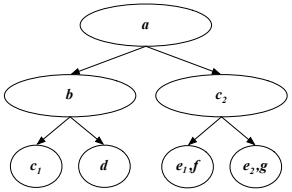

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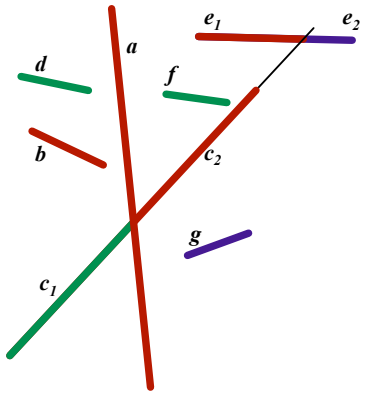

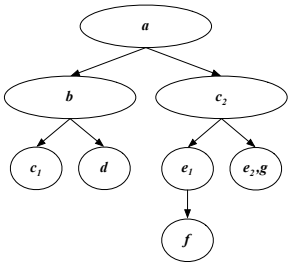

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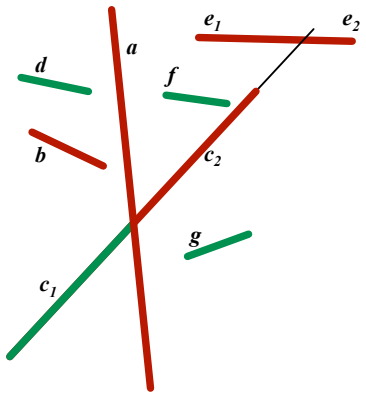

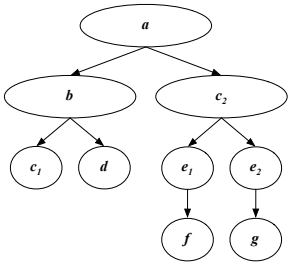

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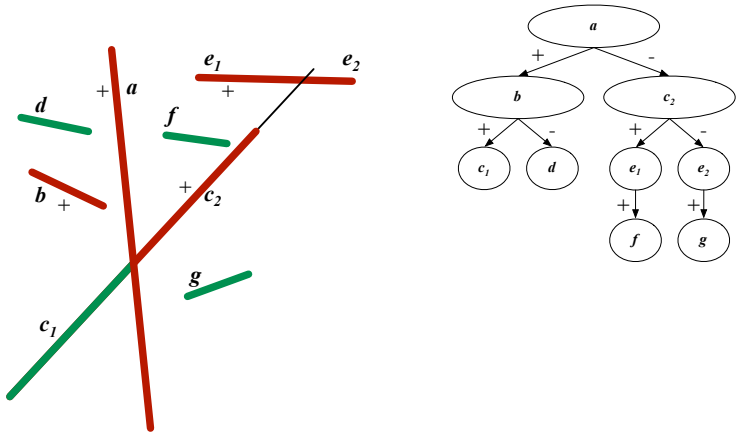
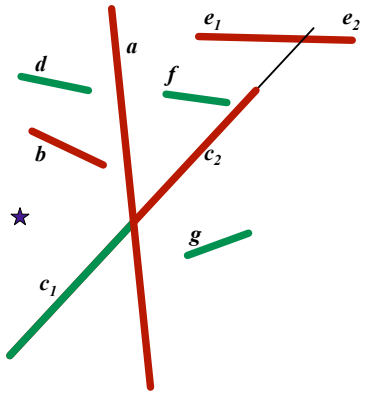
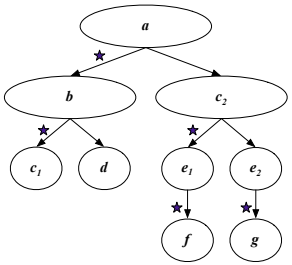


BSP-Trees

- Visibility Traversal
  - Variation of in-order-traversal
    - Child one
    - Sub-tree root
    - Child two
  - Select "child one" based on location of viewpoint
    - Child one on same side of sub-tree root as viewpoint

BSP-Trees





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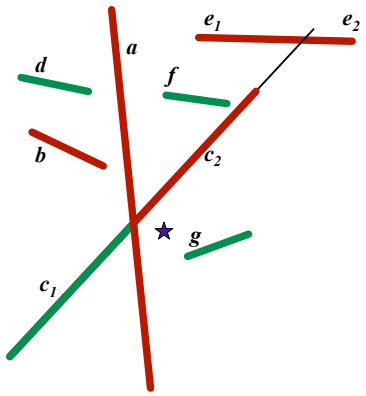
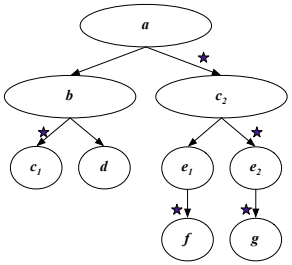
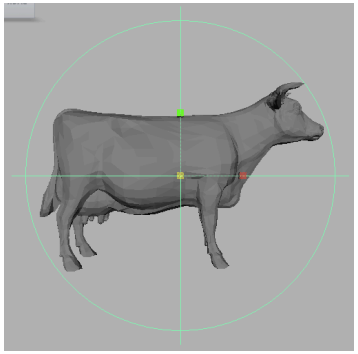
BSP-Trees

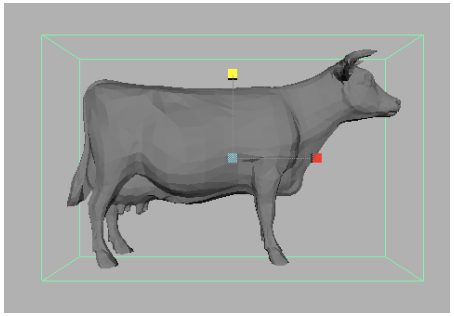




g:e_2:c_2:f:e_1:a:c_1:b:d

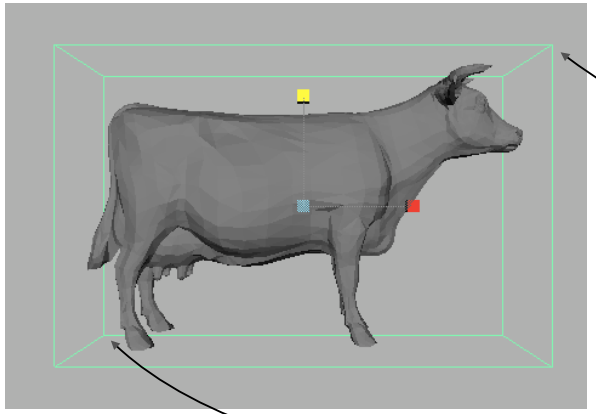
Bounding Shapes





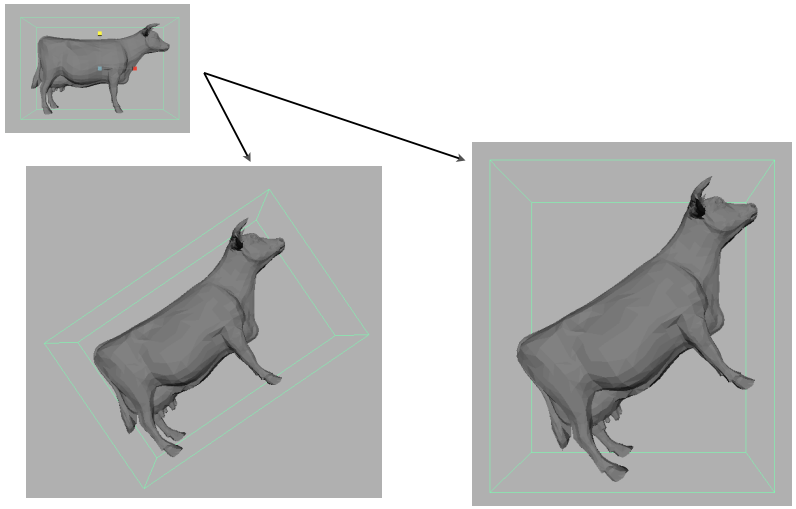
- Bounding shape completely encloses associated object
- Rays cannot hit object w/o intersecting bounding shape
- Two objects cannot collide if shapes don't overlap
- Simplicity -vs- tightness

Axis-Aligned Bounding Boxes



- Axis-aligned bounding box defined by min and max *x,y,z*

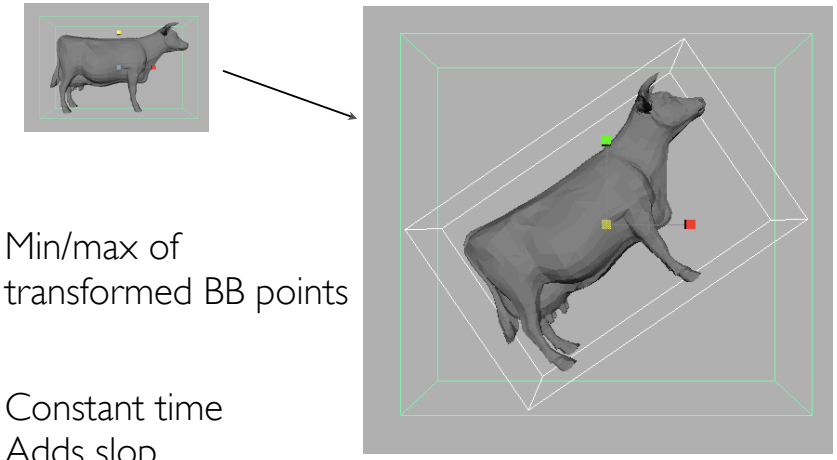
Axis-Aligned Bounding Boxes



Transform box
Not axis-aligned

Min/max of new points
Linear cost to compute

Axis-Aligned Bounding Boxes



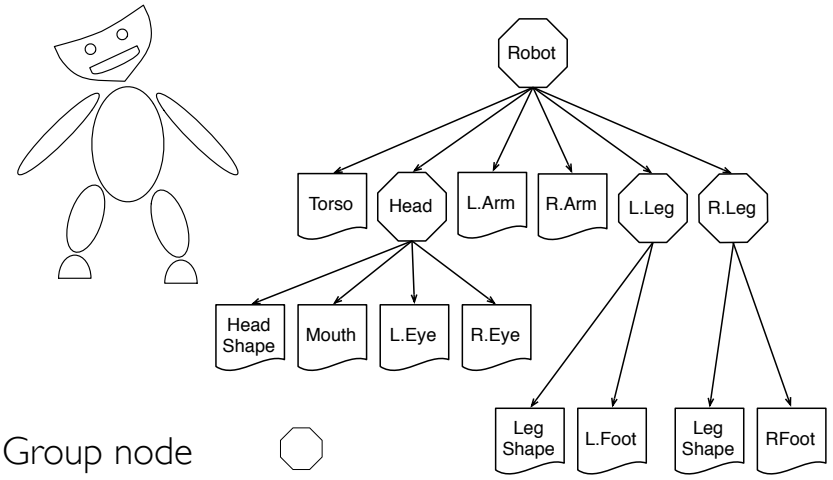
Min/max of
transformed BB points

Constant time
Adds slop
Cumulative slop if multiple transforms occur sequentially

Why would we do this?

AABB Trees

One of many variations



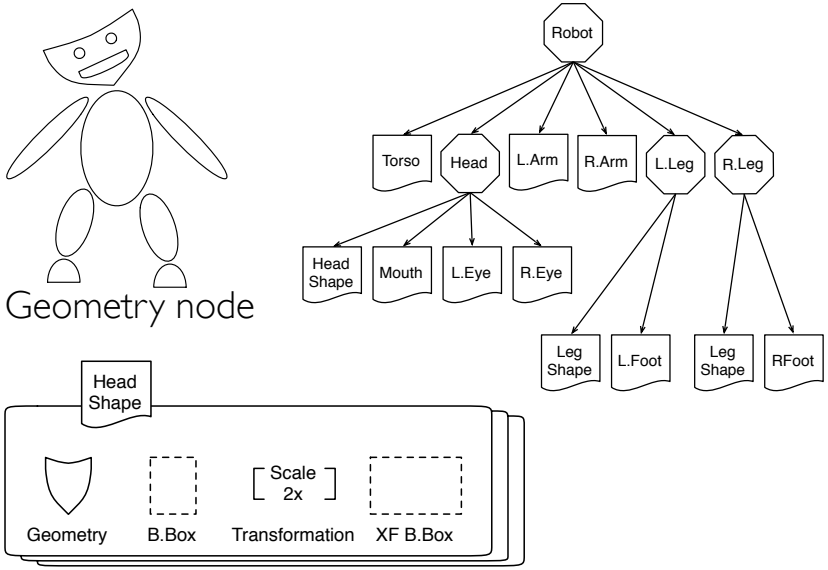
Group node

Geometry node

Transformation stored at all nodes

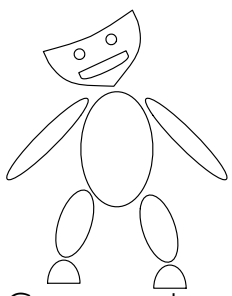
AABB Trees

One of many variations

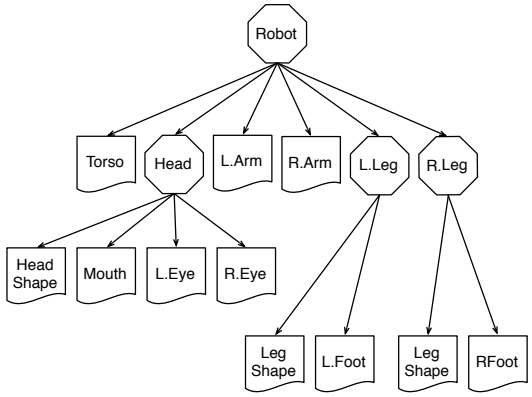


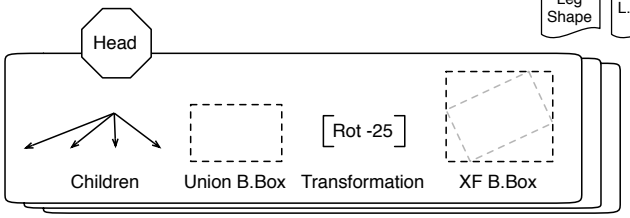
AABB Trees

One of many variations



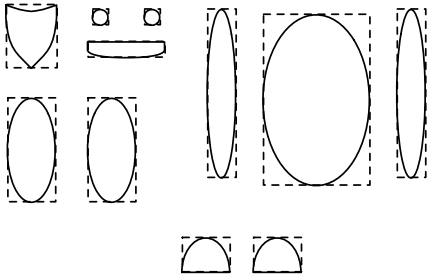
Group node

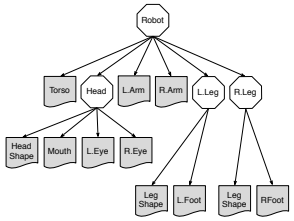




AABB Trees

One of many variations

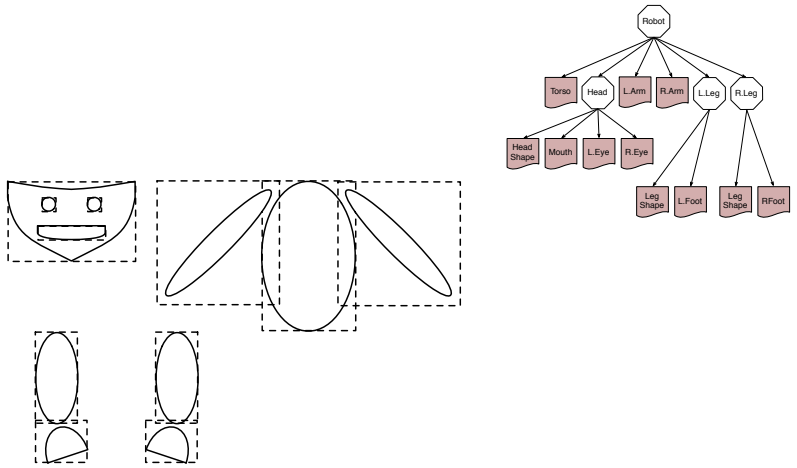




Local Bounding Boxes

AABB Trees

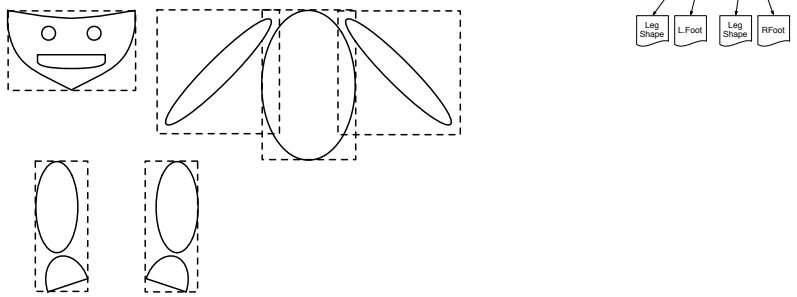
One of many variations

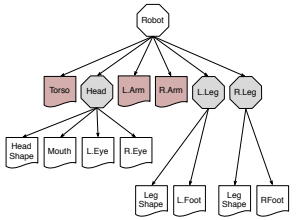


Transformed Bounding Boxes

AABB Trees

One of many variations





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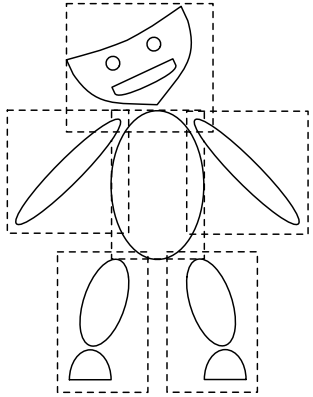

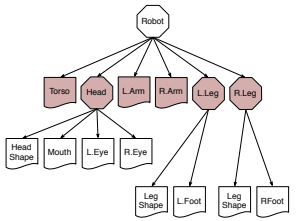

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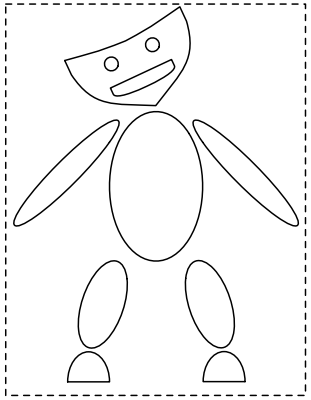

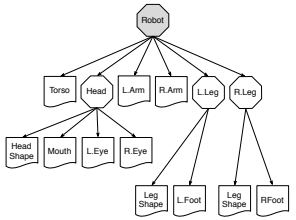

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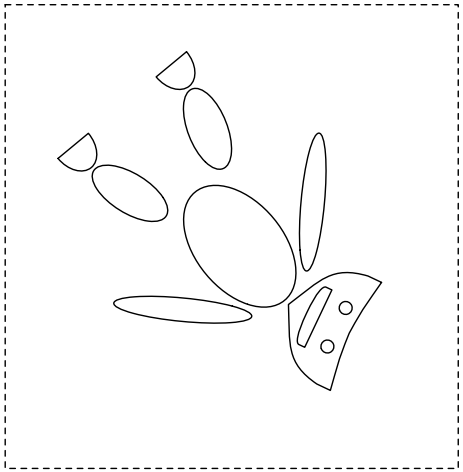

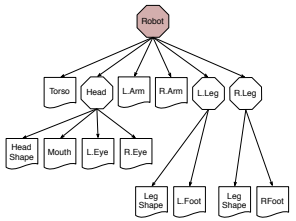

Ray Test Against Bound Tree

- `RayHitSubTree(&ray,node)`
  - `If RayHitsBB(ray,node.xfBB)`
    - `ixfRay = Inverse(node.xf)*ray`
    - `If RayHitsBB(ixfRay,node.BB)`
      - `If node is group`
        - `Foreach child in node.children`
          - `RayHitSubTree(ixfRay,child)`
      - `else // node not group`
        - `RayHitGeometry(ixfRay,node.geom)`
    - `ray.collisionInfo.update(ixfRay)`