
CS770/870 Fall 2008

Binary Space Partitioning

Related material in Hill and Kelley:

09:35

CS770/870 Fall 2008 Bergeron/Plumlee

1

Preview

- Binary Space Partitioning (BSP)
 - preprocess scene by a tree of separating planes
 - can speed up some kinds of processing later
- For visible surface calculation
 - Especially effective if world model changes less frequently than viewing position

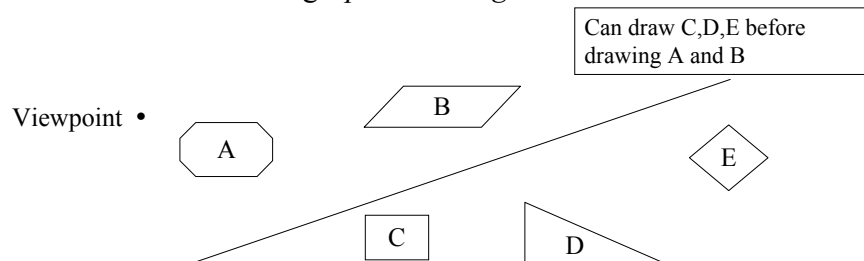
09:35

CS770/870 Fall 2008 Bergeron/Plumlee

2

Separating Plane

- Given a plane and a view point
 - No polygon on the viewpoint side of the plane can be obscured by any polygon on the other side of the plane
 - Hence, can get correct visibility by drawing the other side first using a *painter's algorithm*



09:35

CS770/870 Fall 2008 Bergeron/Plumlee

3

BSP Components

- *makeTree*: preprocessing module that converts a set of input polygons into a BSP tree.
- *traverse*: traverses the BSP tree for a given viewpoint to produce a priority order for drawing the polygons in an essentially *back-to-front* order

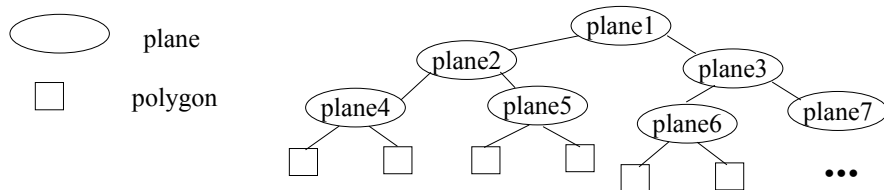
09:35

CS770/870 Fall 2008 Bergeron/Plumlee

4

Partitioning

1. Find a separating plane to partition polygons into 2 sets: those on the + side of the plane and those on the - side of the plane.
2. For each subset, repeat.
find a separating plane to partition those polygons ...



09:35

CS770/870 Fall 2008 Bergeron/Plumlee

5

Building the Tree

- How can we efficiently find separating planes?
- Can we keep the tree simple?
- Overview
 - select a polygon from the polygon list; use its plane as the root of the tree
 - partition remaining polygons to the left and right subtrees
 - if a polygon is intersected by a plane, use the plane to divide it into 2 parts

09:35

CS770/870 Fall 2008 Bergeron/Plumlee

6

makeTree

```

Tree makeTree( polyList )
  if polyList empty
    return null
  else
    rootPoly = remove poly from polyList
    for each p in polyList
      if p on + side of root
        leftList.add( root.left, p )
      else if p on - side of root
        rightList.add( p )
      else
        splitPoly( p, rootPoly, leftList, rightList )
    node.left = makeTree( leftList )
    node.poly = rootPoly
    node.right = makeTree( rightList )
  return node
    
```

09:35

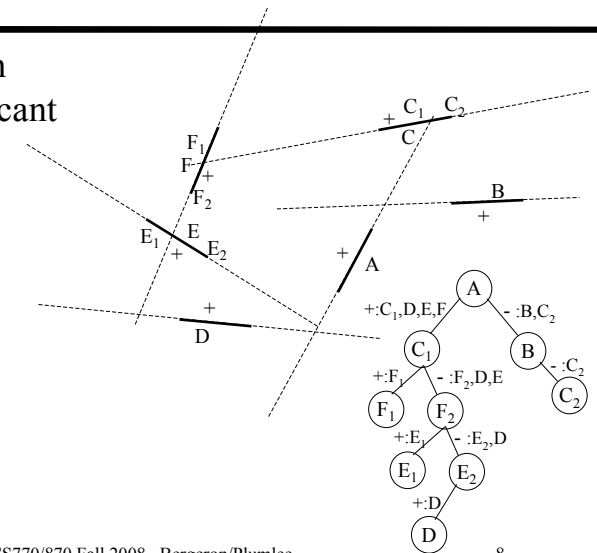
CS770/870 Fall 2008 Bergeron/Plumlee

7

Build a Tree

- Root choice at each level can be significant

1. Pick A as root; splits C
2. Pick C_1 ; splits F
3. Pick B, then C_2
4. Pick F_1 at node C_1
5. Pick F_2 ; splits E
6. Pick E_1
7. Pick E_2
8. Pick D



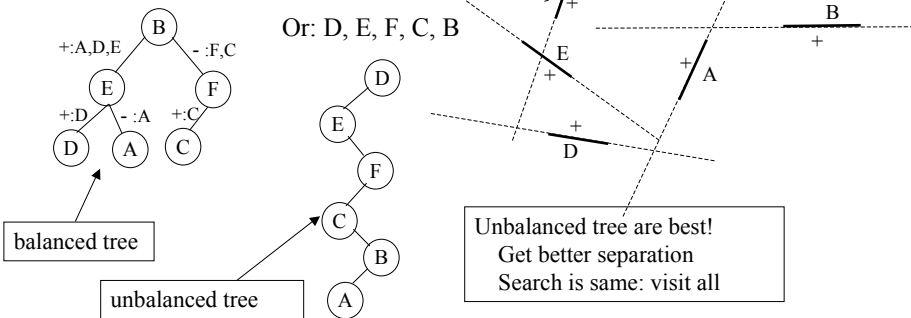
09:35

CS770/870 Fall 2008 Bergeron/Plumlee

8

Alternate choices

- Suppose we start with B, then E and F



09:35

CS770/870 Fall 2008 Bergeron/Plumlee

9

traverseTree

- Given a viewpoint, generate display

```
traverseTree( node, vp )  
  if node not null  
    if vp on - side of node.plane  
      traverseTree( node.plus, vp )  
      display( node.polygon )  
      traverseTree( node.minus, vp )  
    else // vp on + side of node.plane  
      traverseTree( node.minus, vp )  
      display( node.polygon )  
      traverseTree( node.plus, vp )
```

- Notes

- display method transforms to image space, clips, etc.
- display on - side can be eliminated if do backface culling

09:35

CS770/870 Fall 2008 Bergeron/Plumlee

10

Build Tree Variations

- At each step, select polygon whose plane intersects fewest remaining polygons; lots of intersection tests.
- Select n polygons randomly; select the one of these that cuts fewest remaining polygons
 - Fuchs did experiments; recommended about 5 candidate polygons gives reasonable balance of performance to create and reducing intersections

09:35

CS770/870 Fall 2008 Bergeron/Plumlee

11

Dynamic BSP Tree Creation

- BSP tree creation time doesn't matter if scene never changes, but that is a limited environment.
- If most objects don't change at run-time, there are algorithms to "update" a tree.
- Easy algorithm:
 - remove old polygons; relatively easy
 - add polygons at new locations
 - but, not very efficient
- More complex algorithms try to modify in place

09:35

CS770/870 Fall 2008 Bergeron/Plumlee

12