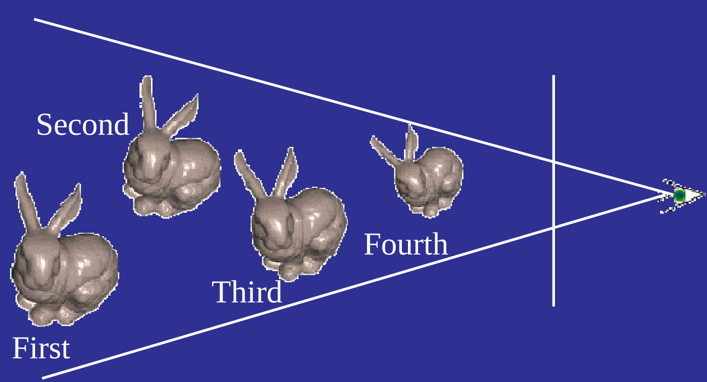
# Painter's Algorithm

- Object-Order Algorithm
- Sort objects by depth
- Display them in back-to-front order

# Painter's Algorithm



# Painter's Algorithm

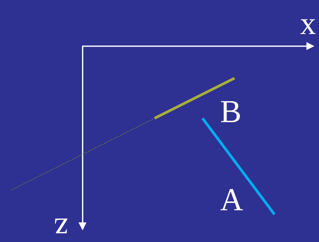
- Sort polygons by farthest depth.
- Check if polygon is in front of any other.
- If no, render it.
- If yes, has its order already changed backward?
  - If no, render it.
  - If yes, break it apart.

# Which polygon is in front?

Our strategy: apply a series of tests.

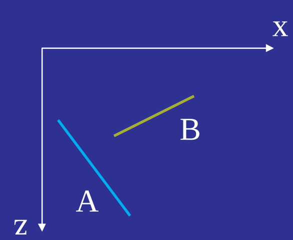
- First tests are cheapest
- Each test says poly1 is behind poly2, or *maybe.*

1. If min z of poly1 > max z poly2, 1 in back.




2. The plane of the polygon with smaller z is closer to viewer than other polygon.

(a,b,c,)*(x,y,z) >= d.

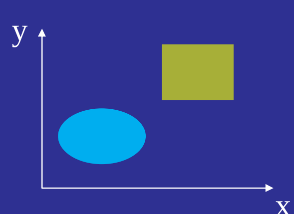



3. The plane of polygon with larger z is completely behind other polygon.

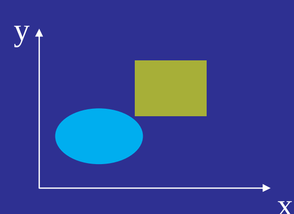
4. Check whether they overlap in image

a. Use axial rectangle test.

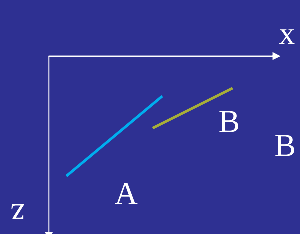
b. Use complete test.




Non-Overlapping x or y

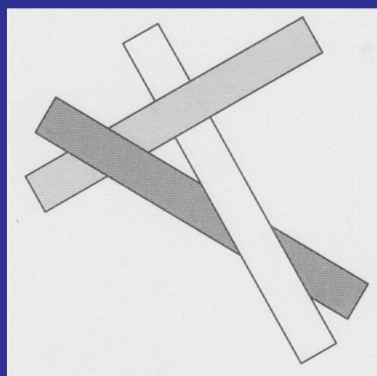


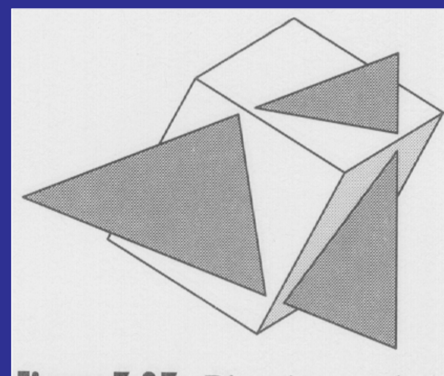

Overlapping projection




B is on one side of A

## Problem Cases: Cyclic and Intersecting Objects





## Painter’s Algorithm

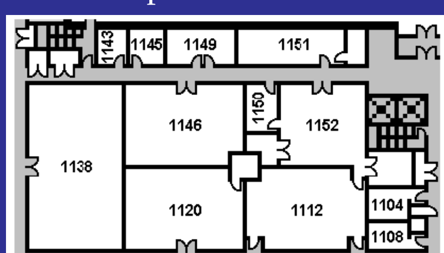
- Solution: split polygons
- Advantages of Painter’s Algorithm
  - Simple
  - Easy transparency
- Disadvantages
  - Have to sort first
  - Need to split polygons to solve cyclic and intersecting objects

# Spatial Data-Structures for Visibility

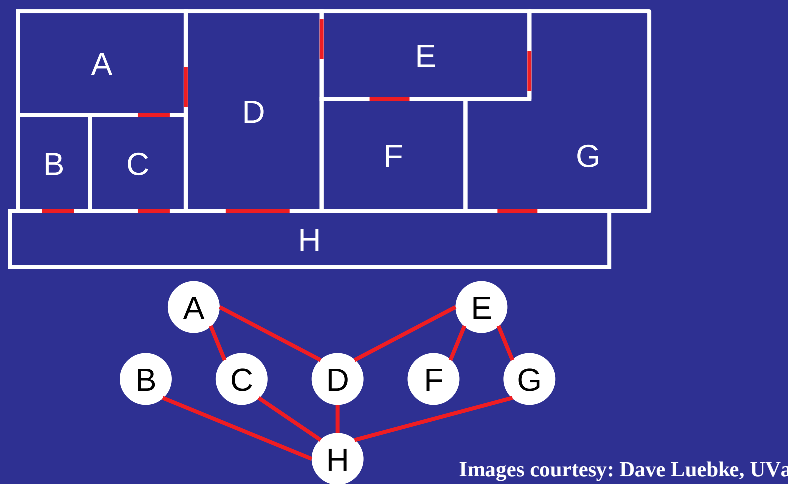
- Octrees (generalization of Binary trees in 1D and Quad trees in 2D)
- Binary-Space Partition Trees (BSP trees) (an alternative generalization of Binary trees in 1D)
- Subdividing architectural buildings into cells (rooms) and portals (doors/windows)

# Portals

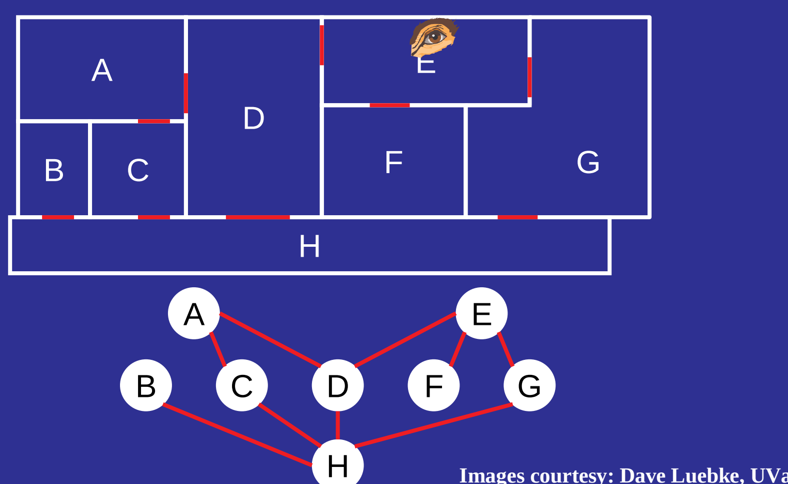
- Similar to view-frustum culling
- View-independent
- Preprocess and save a list of possible visible surfaces for each portal



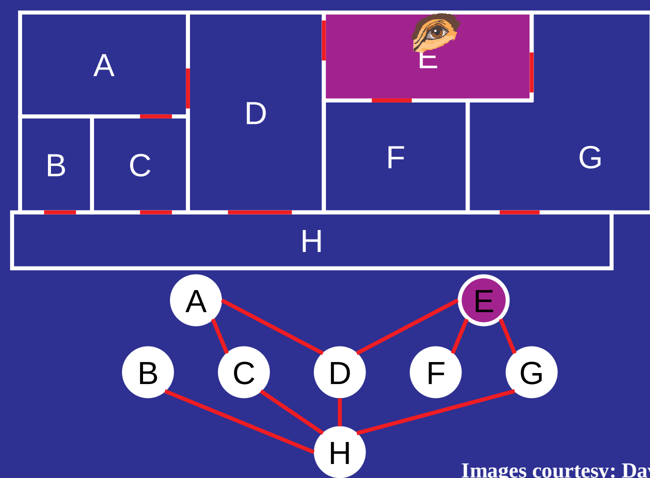
# Cells and Portals




# Cells and Portals

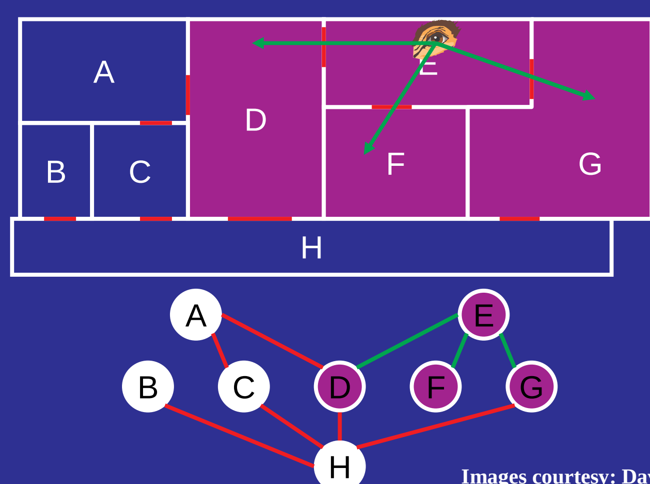


## Cells & Portals



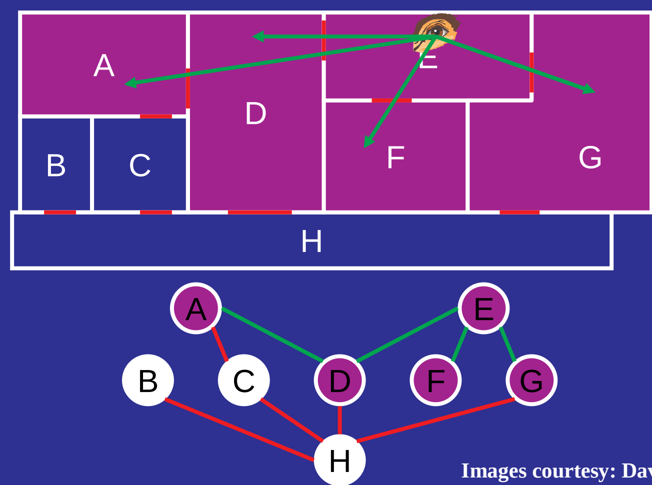

Images courtesy: Dave Luebke, UVa

## Cells & Portals




Images courtesy: Dave Luebke, UVa

# Cells & Portals




Images courtesy: Dave Luebke, UVa

# BSP Trees

- Idea

  Preprocess the relative depth information of the scene in a tree for later display

- Observation

  The polygons can be painted correctly if for each polygon F:
  - Polygons on the other side of F from the viewer are painted before F
  - Polygons on the same side of F as the viewer are painted after F

## Building a BSP Tree

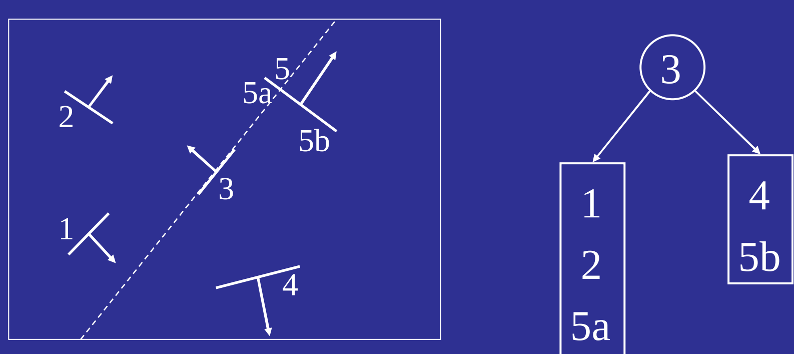
```
Typedef struct {
    polygon root;
    BSP_tree *backChild, *frontChild;
} BSP_tree;

BSP_tree  *makeBSP(polygon *list)
{
    if( list = NULL) return NULL;

    Choose polygon F from list;
    Split all polygons in list according to F;

    BSP_tree* node = new BSP_tree;
    node->root = F;
    node->backChild = makeBSP( polygons on front side of F );
    node->frontChild = makeBSP( polygons on back side of F );
    return node;
}
```

## Building a BSP Tree (2D)



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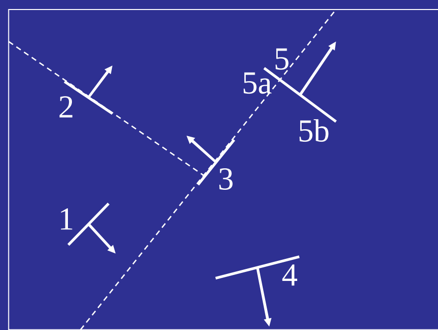


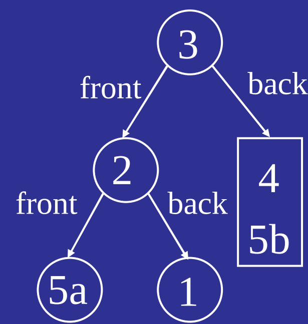


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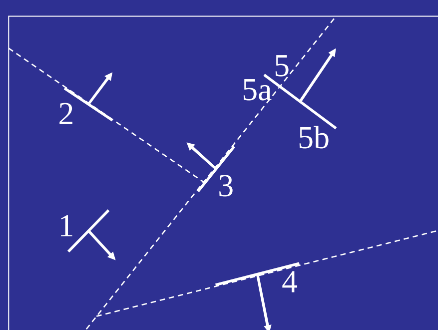
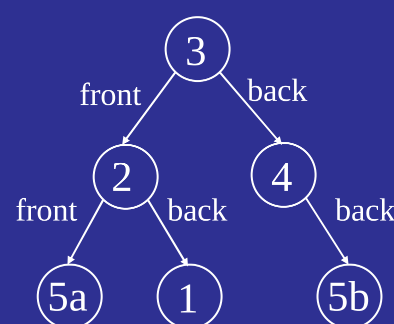
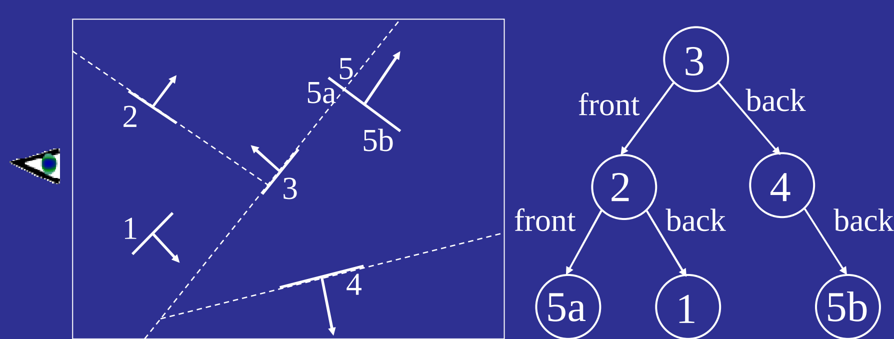


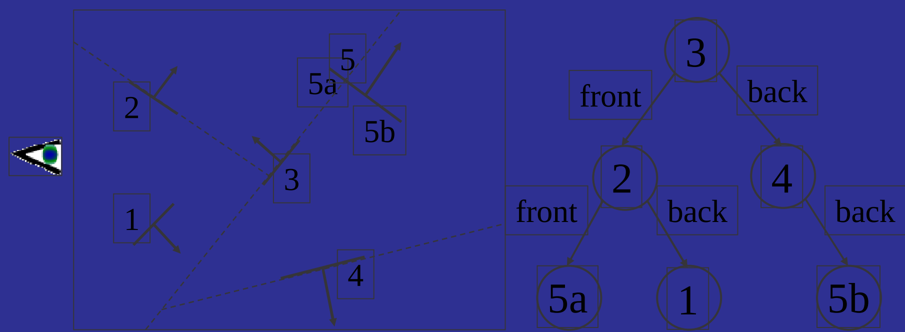
## Displaying a BSP Tree

```
void  displayBSP ( BSP_tree *T )
{
    if ( T != NULL) {
        if ( viewer is in front of T->root ) {    // display backChild first
            displayBSP ( T->backChild );
            displayPolygon ( T->root );
            displayBSP ( T->frontChild );
        }
        else {     // display frontChild first
            displayBSP ( T->frontChild );
            displayPolygon ( T->root );
            displayBSP ( T->backChild );
        }
}
```

## Displaying a BSP Tree




Display order:  4, 5b, 3, 5a, 2, 1 (only 3 is front facing)




# BSP Trees: Analysis

- Advantages
  - Efficient
  - View-independent
  - Easy transparency and antialiasing
- Disadvantages
  - Tree is hard to balance
  - Not efficient for small polygons