Depth sorting

- Logically like painter's algorithm, except that problem cases are handled properly (painters++).
- First, sort polygons in order of decreasing depth
  - (based on closest point)
- Render in sorted order as described next slide.
- Each polygon encountered is checked using several tests to see if it is safe to paint (otherwise fix).
- Structure cases so that cheap tests are done first, and hope that expensive tests do not occur too often.

Depth sorting

- For surface S with greatest depth
  - if no depth overlaps (z extent do not intersect) with other surfaces, then render (like painter's algorithm), and remove surface from list
    - test for depth overlaps by considering the z bounds (extents).
  - if a depth overlap is found, test for problem overlap in image plane
  - if S, S' overlap in depth and in image plane, swap and try again
  - if S, S' have been swapped already, split one across plane of other (like clipping) and reinsert

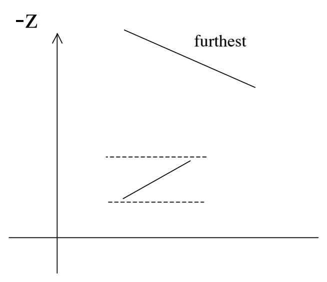
Depth sorting

- Testing image plane problem overlaps (test get increasingly expensive):
  - xy bounding boxes do not intersect
  - *or* S is behind the plane of S'
  - *or* S' is in front of the plane of S
  - *or* S and S' do not intersect

See figures

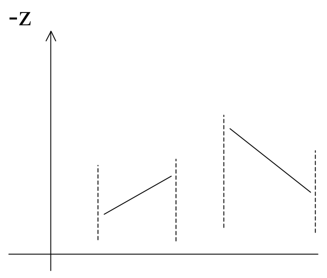
- Advantages:
  - filter anti-aliasing works fine
  - no depth quantization error
  - works well if not too much depth overlap (rarely get to expensive cases)
- Disadvantages:
  - gets expensive with lots of depth overlap (over-renders)

Depth sorting (2D illustrations)



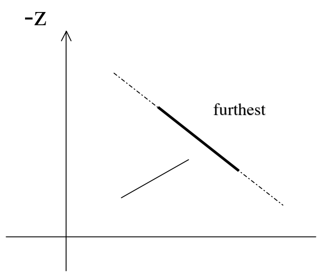
No depth overlap between furthest object and rest of list--paint it.

Depth sorting (2D illustrations)



Overlap in depth, but no overlap in image plane which can be resolved by studying bounding boxes.

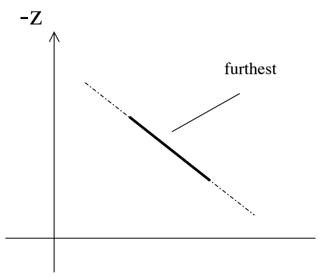
Depth sorting (2D illustrations)



It is safe to paint the furthest, but figuring this out requires observing that the near one is all on the same side of the plane (dotted line) of the furthest.

I.e, the near polygon is in front of the plane of the far polygon.

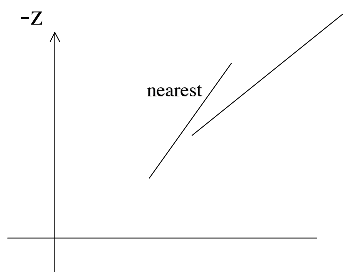
Depth sorting (2D illustrations)



It is safe to paint the furthest, but figuring this out requires observing that it is all on the other side of the plane (dotted line) of the nearest plane.

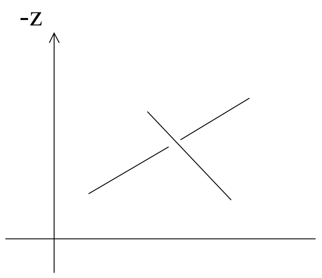
I.e, the far polygon is behind the plane of the near polygon.

Depth sorting (2D illustrations)



The furthest (as defined by the closest point) obscures the “nearest”. It is safe to paint the “nearest”, but figuring this out requires reversing the nearest and furthest, and then reapplying one of the previous tests.

Depth sorting (2D illustrations)



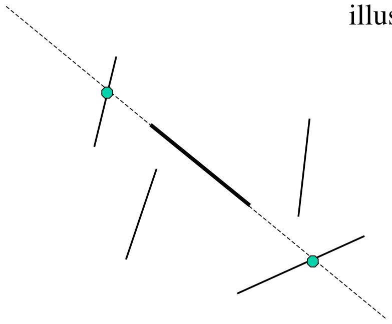
If the preceding tests fail, we have to split the far polygon (line in the drawing) with the plane of the near polygon (**basically a clip operation**), and put the pieces into the list, and carry on.

BSP - trees

- Construct a tree that gives a rendering order
- Tree recursively splits 3D world into cells, each of which contain at most one piece of polygon.
- Constructing tree:
  - Choose polygon (arbitrary)
  - split its cell using plane on which polygon lies
  - continue until each cell contains only one polygon

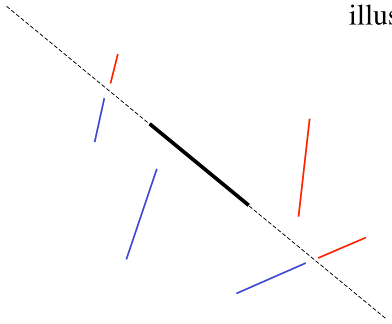
BSP - trees

2D version for illustration



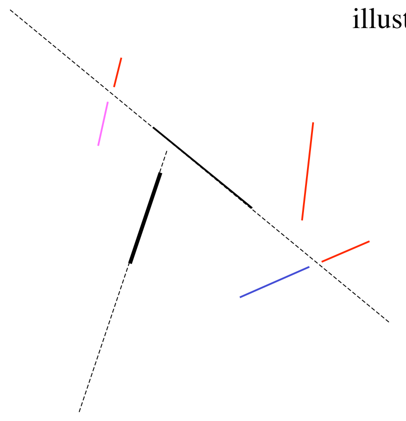
BSP - trees

2D version for illustration



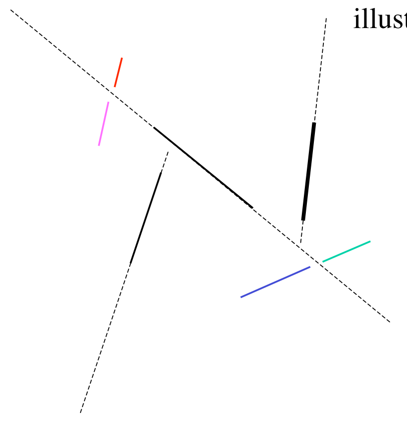
BSP - trees

2D version for illustration



BSP - trees

2D version for illustration



BSP - trees

- Rendering tree:
  - recursive descent
  - render back, node polygon, front
- Disadvantages:
  - many small pieces of polygon (more splits than depth sort!)
  - over rendering (does not work well for complex scenes with lots of depth overlap)
- Advantages:
  - one tree works for all focal points (good for cases when scene is static)
  - filter anti-aliasing works fine, as does transparency
  - data structure is worth knowing about
- Comment
  - expensive to get approximately optimal tree, but for many applications this is can be “off-line” in a pre-processing step.