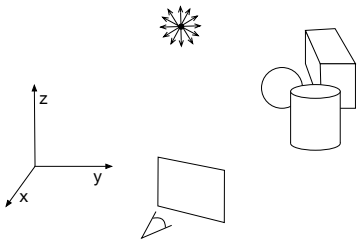
Overview of Realism



Given: model, material properties, eye/camera, lights

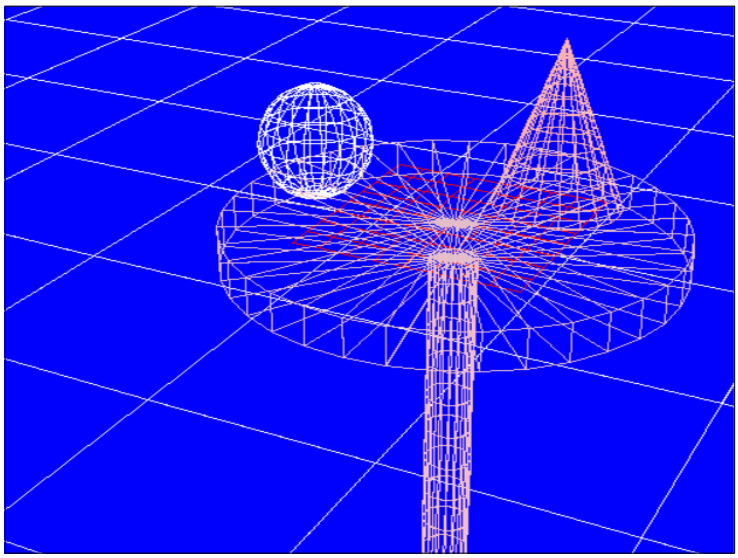
Question: what do I see?

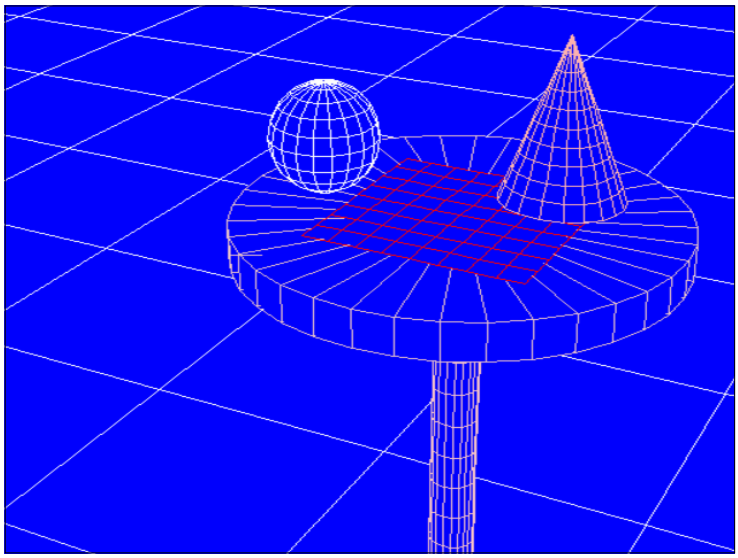
Why Realism?

- better way to convey info (1 pic = 1K words)
- spatial relationships
- simulation, design, entertainment, education, etc

Line Drawing?

- perspective
- depth cues
- depth clipping
- color
- texture
- hidden line removal



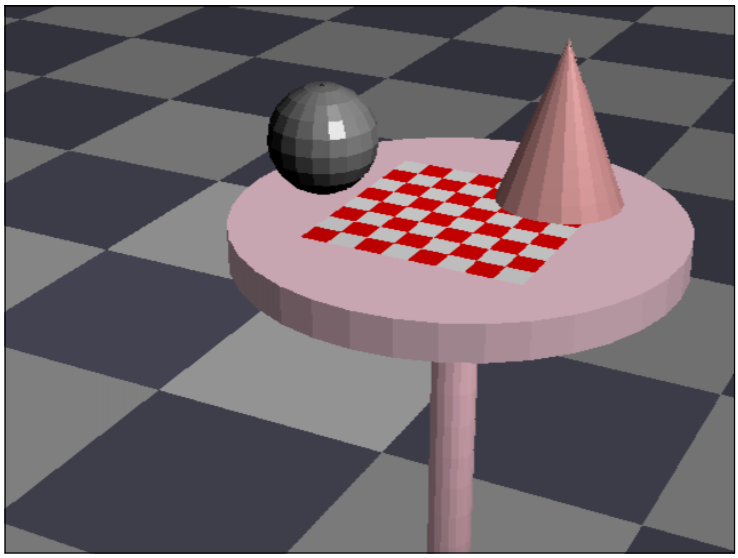


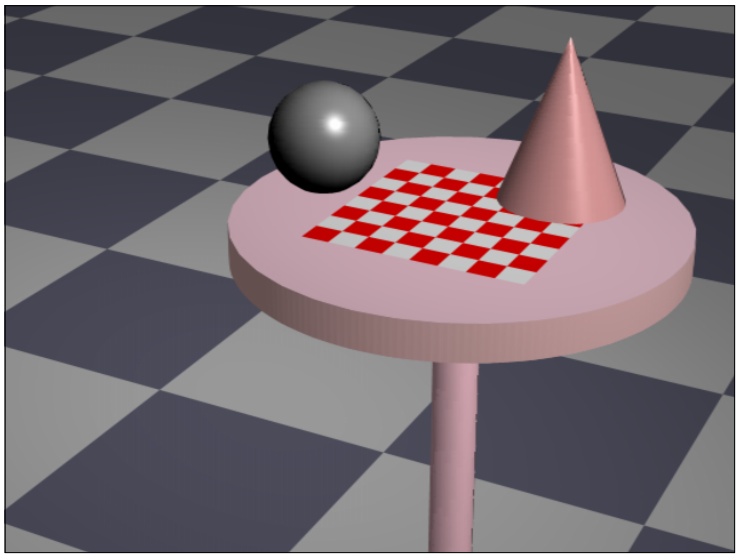
Shaded Images

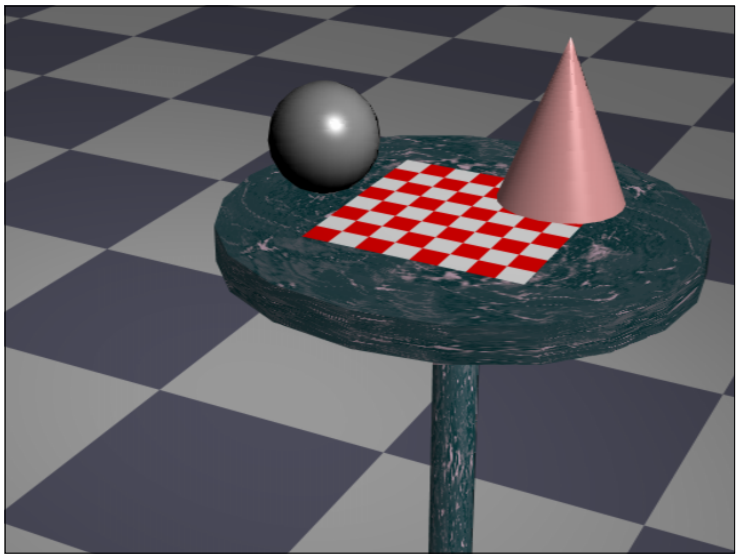
- visible surface determination
- illumination and lighting
- interpolated shading
- material properties
- better lighting models
- curved surfaces

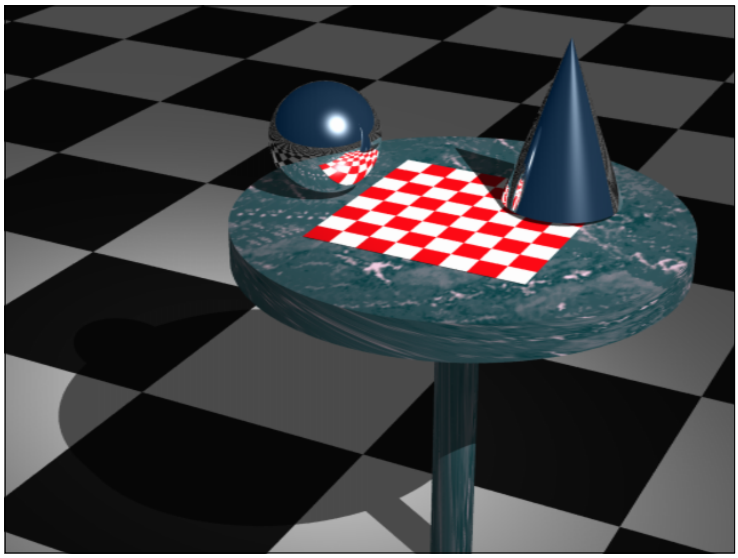
Shaded Images

- texture
- transparency/reflection
- camera models
- object models
- dynamics







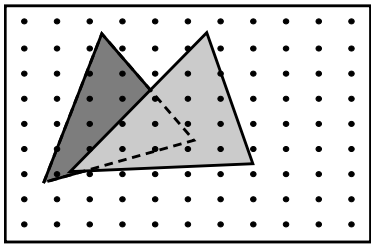


Visible Surface Determination

- two fundamental approaches:
  - image space (image precision)
  - object space (object precision)
- involve a sort

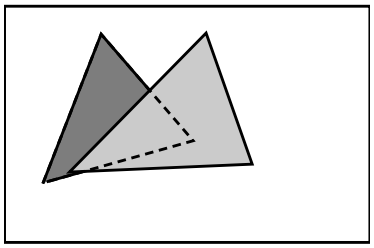
Image Space

- for each pixel in image:
  - determine object closest to viewer
  - draw pixel appropriate color



Object Space

- for each object in scene:
  - determine parts of object that are unobstructed
  - draw those parts appropriate color



Object Space Algorithms

- developed first
- developed for vector displays (hidden lines)
- high-res (4k · 4k ++)
- limited number of objects (typically polygons) (flicker, n^2)
- pen plotters

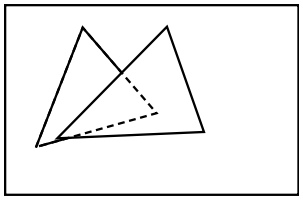


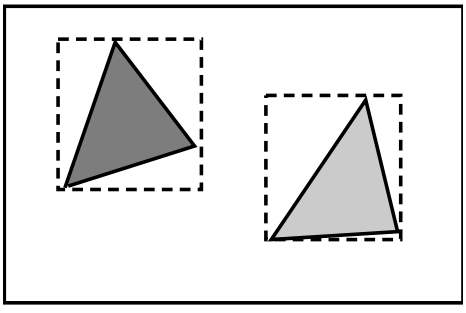
Image Space Algorithms

- low-res originally
- can display unbounded number of objects
- potentially wider range of primitives

Techniques for Efficient Visible Surface Algorithms

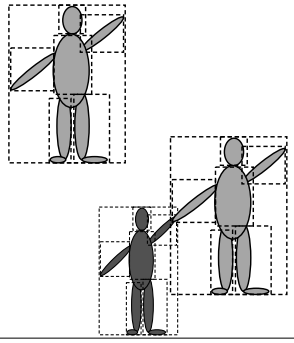
- **coherence**: degree to which parts of environment or its projection exhibit local similarities
- examples of types of coherence: object, face, edge, scan-line, area, depth, frame

Bounding Boxes/Volumes

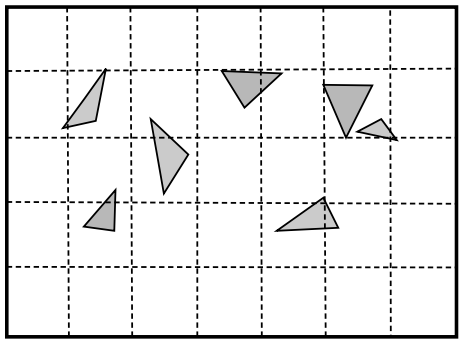


Hierarchy

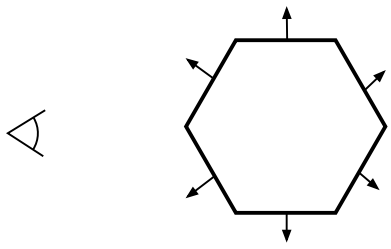
- if objects don't intersect neither do sub-objects



Spatial Partitioning

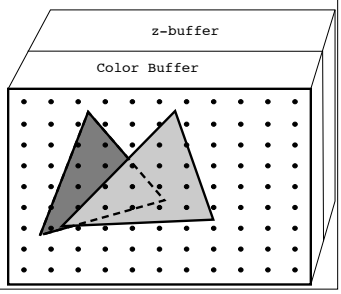


Back Face Culling



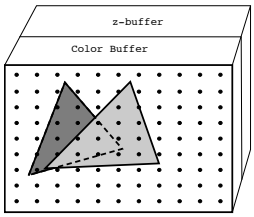
VSA: Z-Buffer (depth buffer)

- 2 buffers: color buffer, z-buffer
- compare during scan conversion:
  - if depth of new fragment is closer
    - update color buffer
    - update z-buffer



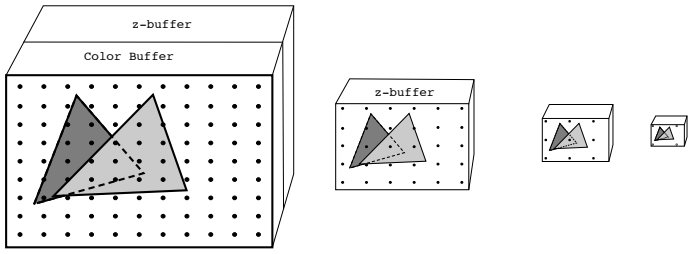
Z-Buffer

- Advantages:
  - wide range of primitives
  - arbitrary # of objects (deal with one at a time)
  - simple -> hardware
- Disadvantage:
  - color buffer, z-buffer memory
  - image space



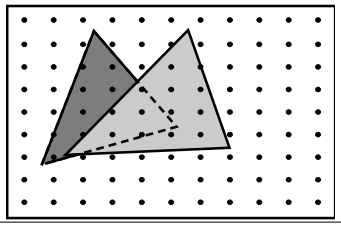
VSA: Hierarchical Z-Buffer

- multiple resolutions (factor of 2)
- can deal with much larger data sets



VSA: Painters Alg

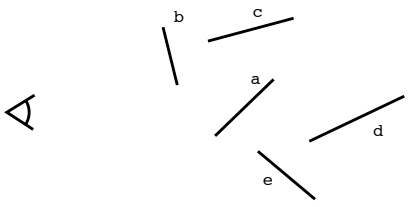
- sort polygons back to front
- resolve any ambiguities
  (use extents, clip if necessary)
- scan-convert polygons back to front



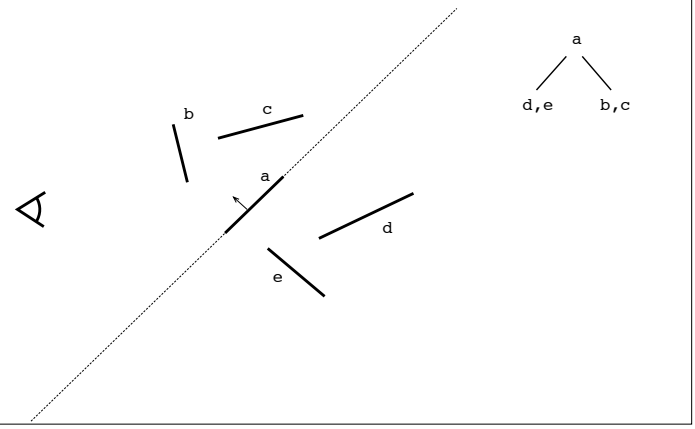
Painters Alg

- Advantages:
  - relatively simple
- Disadvantages:
  - need frame buffer
  - memory for polygons
  - resolving ambiguities
  - image space

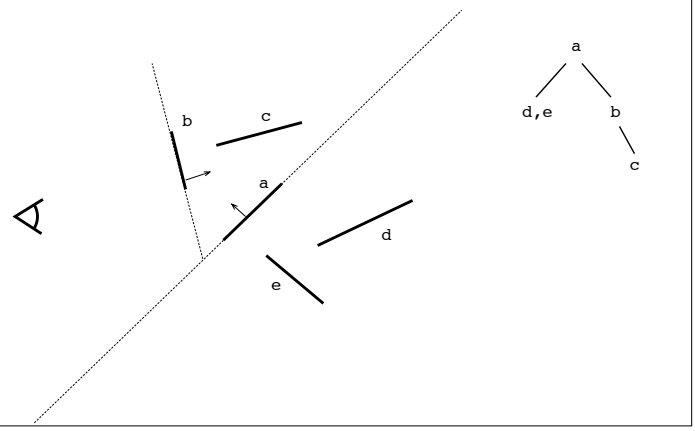
VSA: Binary Space Partitioning Trees (BSP Trees)



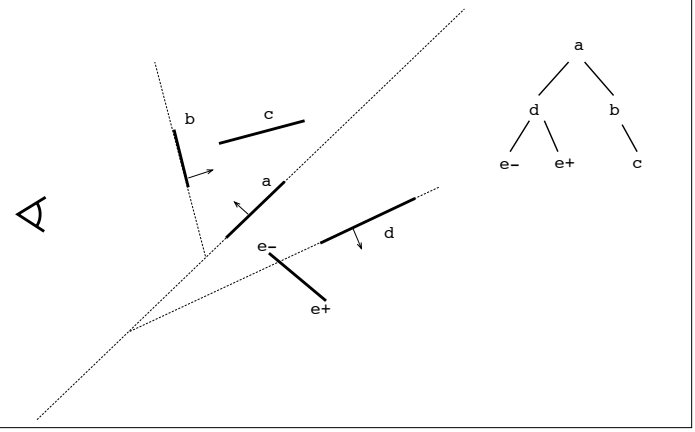
BSP-Trees



BSP-Trees



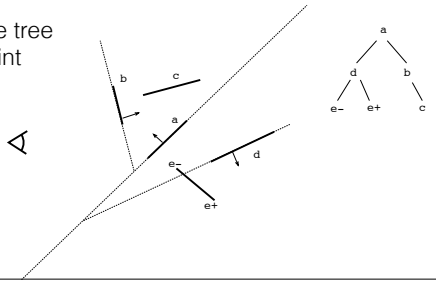
BSP-Trees



BSP-Trees

Draw in priority order (back to front)

- create tree of subspaces (nodes store polygon, separating plane)
- recursively traverse tree using lookFrom point
- visit order:
  - far
  - plane
  - near



BSP-Trees

- Advantages:
  - interactive if only eye changes
- Disadvantages:
  - high tree-building cost
  - need memory for color buffer, tree, polygons