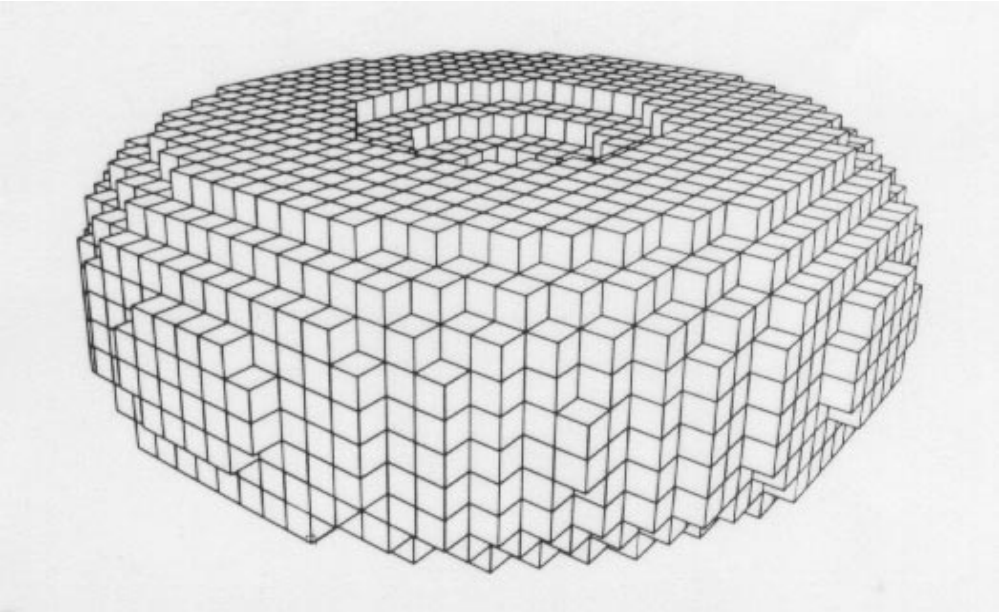
Spatial Decomposition

- ☆ Divide the space into *primitive* cells.
- ☆ Represent all cells lying in the object.

Spatial occupation enumeration

- ☆ Divide the space into identical cells arranged in a fixed regular grid structures.
- ☆ 3D Analog of 2D images.
- ☆ Cells are often cubes and are called *voxels*.
- ☆ Popular representation in volume rendering and CAT.
- ☆ High storage requirement.

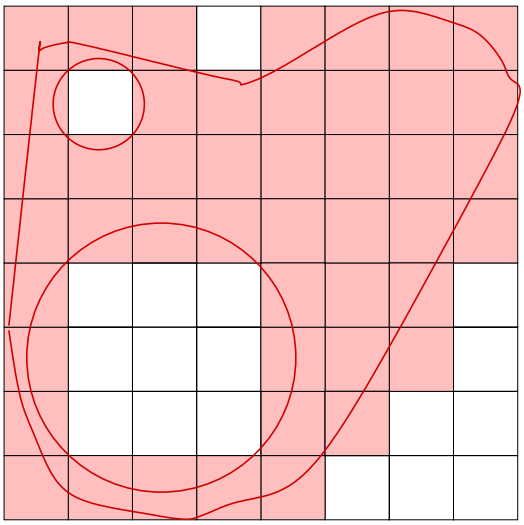


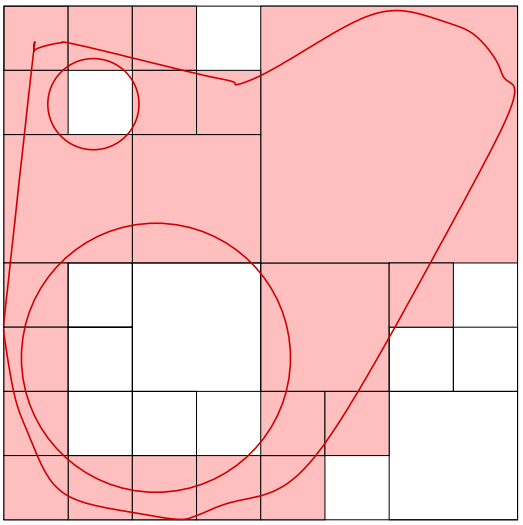
Oct Trees

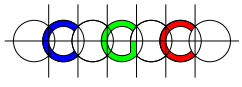
- ☆ Hierarchical representation.
- ☆ Requires much less space.
- ☆ Extension of 2D *quad tree*.

Quad tree:

- ☆ Recursively subdivide the plane into four squares by bisecting it in both directions.
- ☆ A square is *full, empty, partially full*.
- ☆ A partiually full square is further subdivided.
- ☆ Parttioning continues until a cutoff threshold is reached.

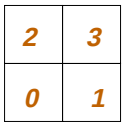




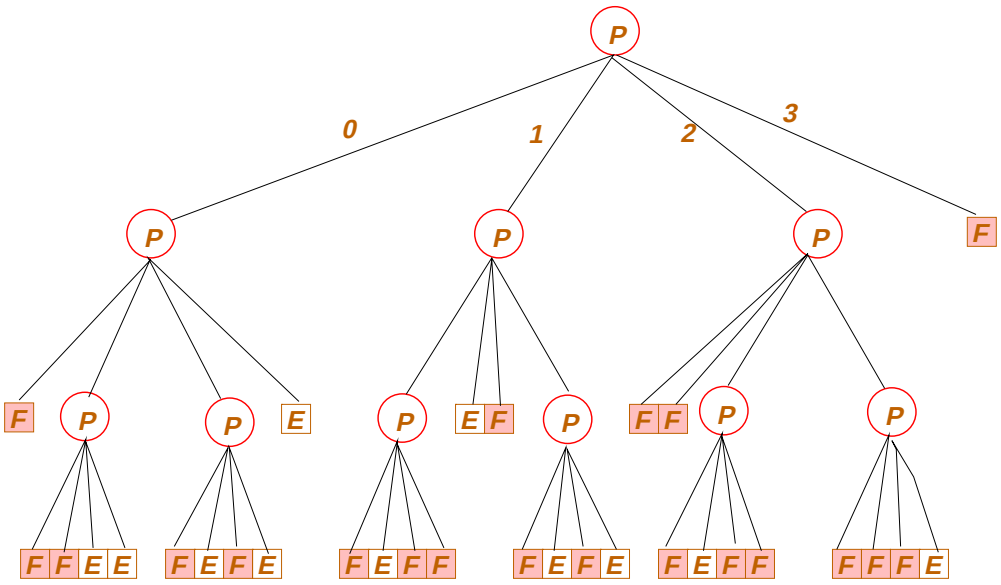


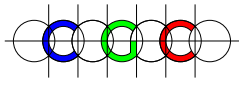
Quad Trees

- ☆ Can be reprsented as a 4-way tree.
- ☆ Each node v represents a square Q_v
  - If $Q_v \subseteq P$, v is *black*.
  - If $Q_v \cap P = \emptyset$, v is *white*.
  - Otherwise v is *gray*.
  - Gray nodes are further subdivided.



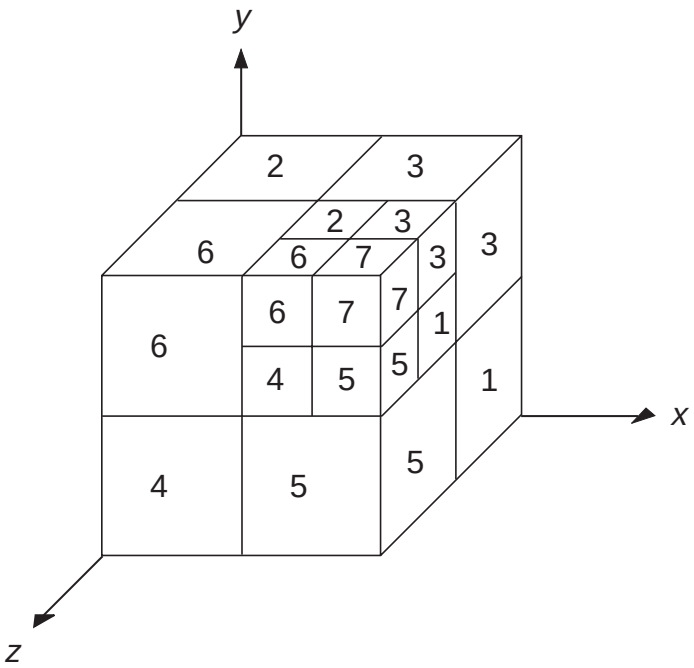
Quadrant Numbering



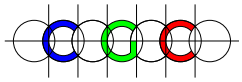


Oct Trees

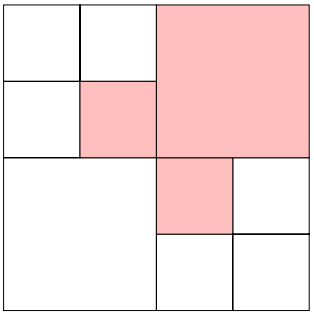
- ☆ Oct tree is a similar to quadtrees.
- ☆ Each cube is divided into eight octants.
- ☆ Useful for many operations, e.g., collision detection, ray tracing.

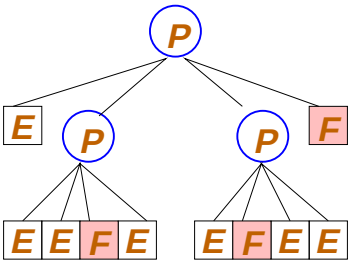


- ☆ Space requirement is still large. item Sensitive to the position of the object.
- ☆ Only approximate representation for nonorthogonal objects.

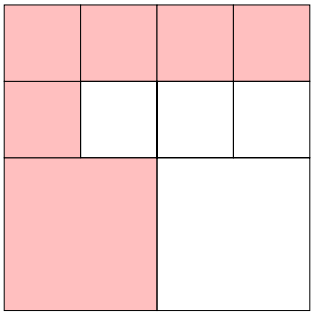


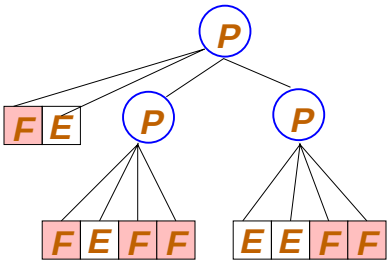
Boolean Operations on Quad Trees



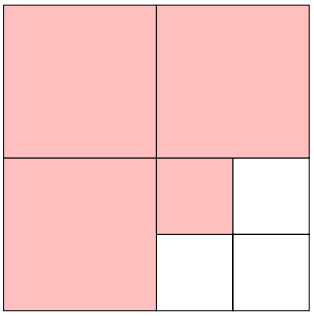


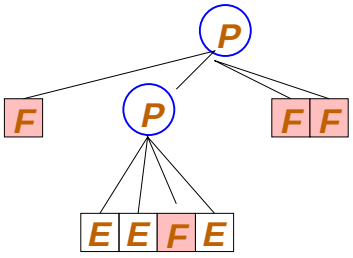
Object S



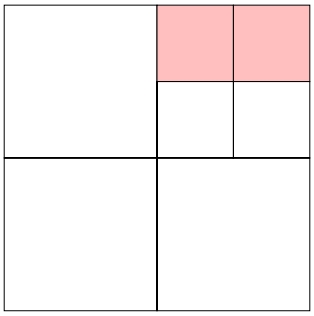


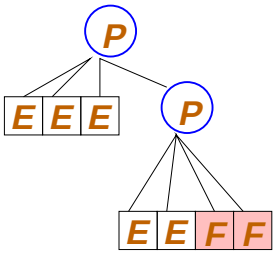
Object T



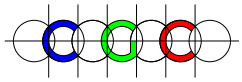


Union (S, T)



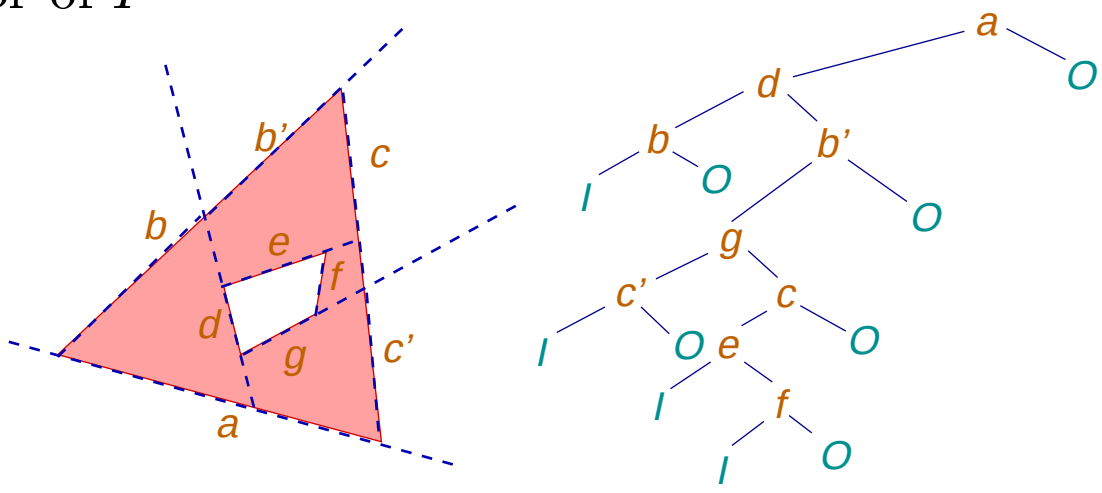


Intersection (S,T)



Binary Space Partiton (BSP) Trees

P: Polyhedron; Normal of each face point to exterior of P



- ☆ Each interior node v is associated with a plane π_v (containing a face of P) and convex polytope Q_v.
  - π_v^+: outside halfspace bounded by π_v.
  - π_v^-: inside halfspace bounded by π_v.
- ☆ The left child w of v is associated with $Q_v \cap \pi^-$.
- ☆ If Q_w is monochromatic, w is a leaf.
- ☆ The right child x of v is associated with $Q_v \cap \pi^+$.
- ☆ If Q_z is monochromatic, w is a leaf.