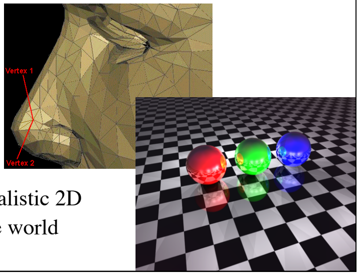
Computer graphics
Ray tracing

Putting it all together

Our last real lecture!!

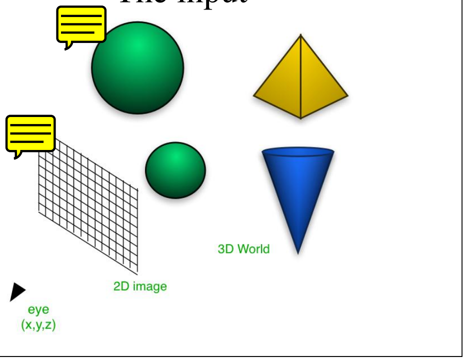
Computer Graphics Rendering

- World is represented by a set of 3D objects, with colors, reflectivity, transparence, etc.
  - Primite objects: Polygons, spheres, cones
  - Complex objects: Mesh of triangles

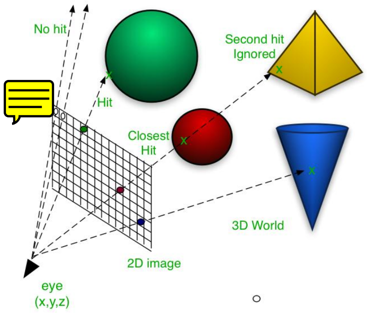


- Goal: Produce a realistic 2D picture of the world

The input



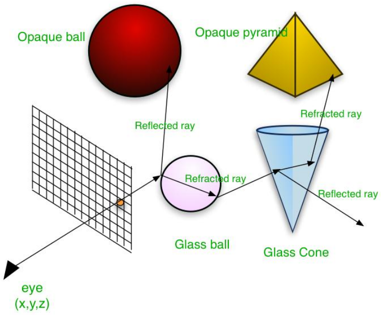
Ray-tracing

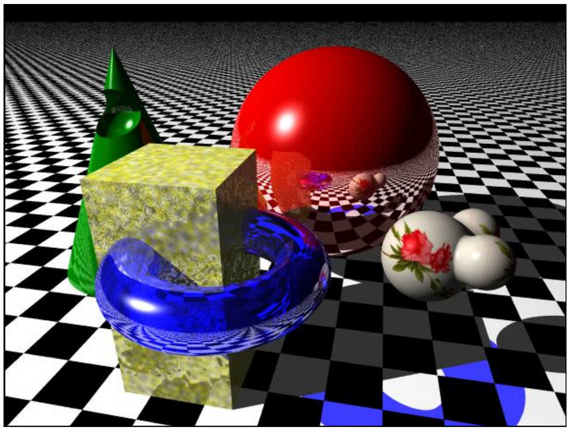


Ray-tracing algorithm

```
Input: - world: set of 3D objects
          - (x,y,z) position of the eye
          - Position of the 2D screen
Output: Image: array of colors of size nPixels by mPixels
For i = 1…nPixels
   For j = 1…mPixels
        r = ray( eye -> pixel(i,j) )
        object = getClosestIntersection(r, world)
        if (object!=null) then
                image[I,j] = object.getColor();
```

Recursive Ray-tracing





Finding intersections

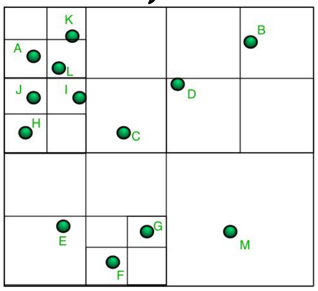
- Suppose your world consists of Millions of objects
- How can you calculate closest intersection quickly?
  - Computing intersection between ray and each object is much too slow
- Idea: Store your objects in a data structure that allows you to quickly discard objects that can’t have intersection

Quad trees

For a 2D-world, Subdivide the world into four quadrants.

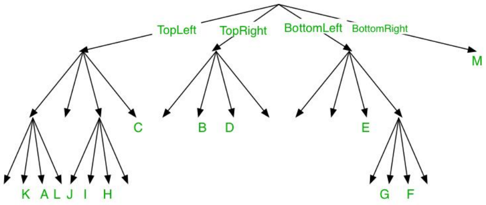
Keep subdividing as long there is more than one object per square

For 3D-world, Subdivide world into eight octants



Quad trees

Subdivision is represented as a tree:
Root = complete world
Children = four quadrants



Fast ray intersection problem

To quickly find intersection between ray and world:

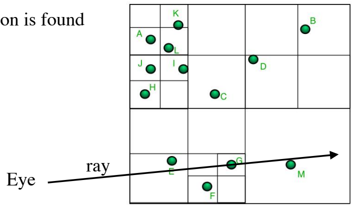
Find which main quadrant is intersected

Find which of its subquadrant is intersected

… Keep going down the tree until a leaf is found

If leaf contains an object, test intersection

Continue until intersection is found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