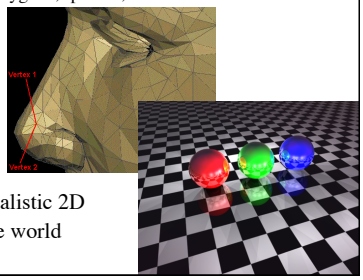
# Computer graphics
# Ray tracing

Putting it all together

Our last real lecture!!

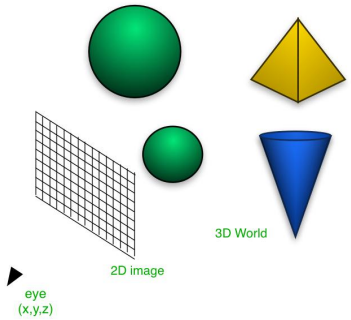
## Computer Graphics Rendering

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

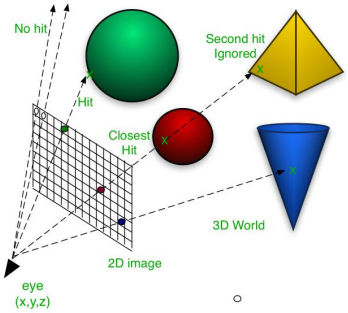



- Goal: Produce a realistic 2D picture of the world

## The input




## Ray-tracing



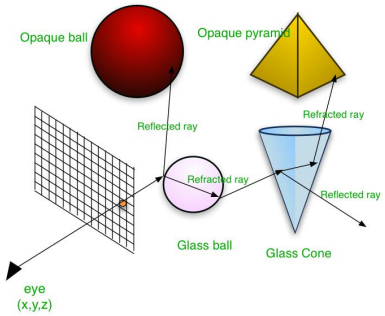

## Ray-tracing algorithm

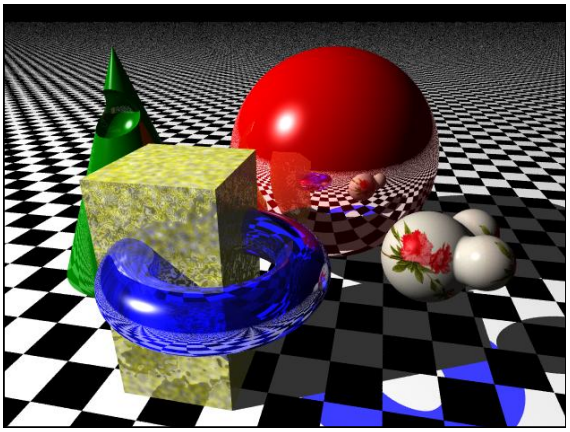
Input: - world: set of 3D objects
- (x,y,z) position of the eye
- Position of the 2D screen

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

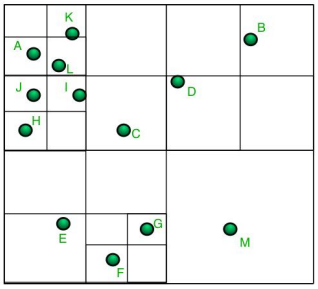
- Suppose your world consists of Millions of objects
- How can you calculate closest intersection quickly?
  - Computing intersection between ray and each object is much too slow
- Idea: Store your objects in a data structure that allows you to quickly discard objects that can't have intersection

## Quad trees

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

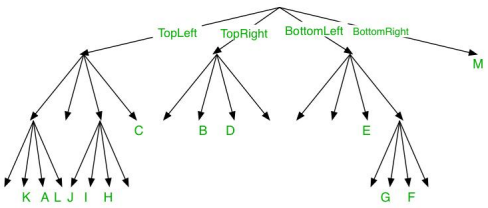
Keep subdividing as long there is more than one object per square

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