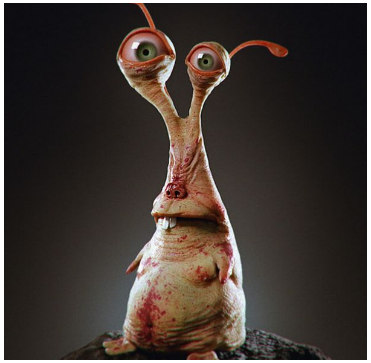
Ray Tracer extensions

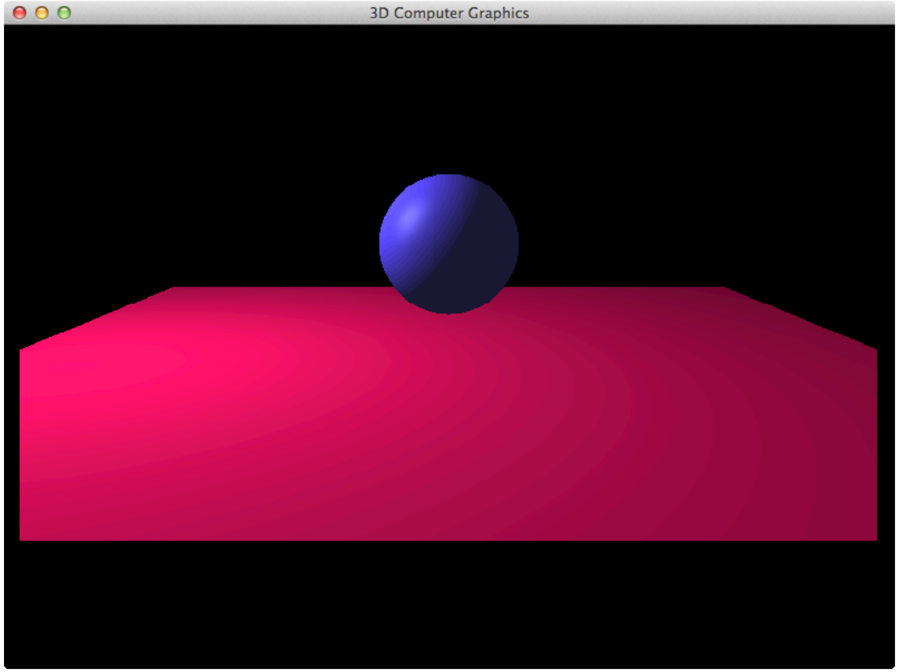
3D Computer Graphics (Lab 9)

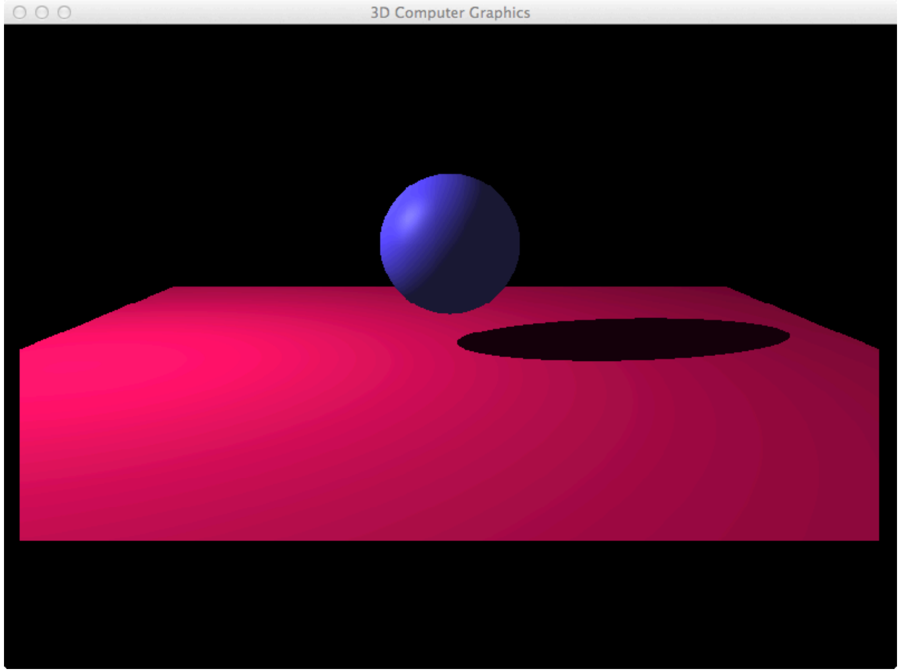


Shadows

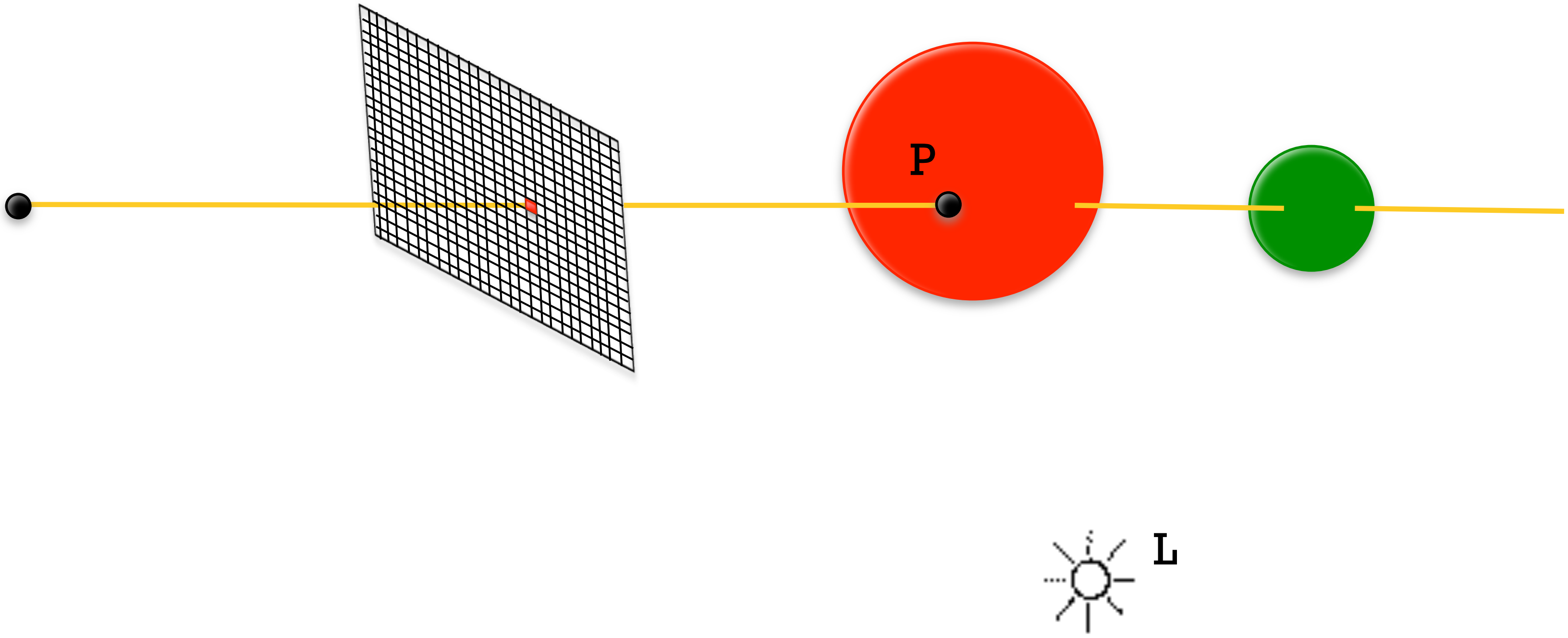
Before …

After …





Ray tracing



How do we compute the colour of the hitPoint P?

We use a simple shading model:

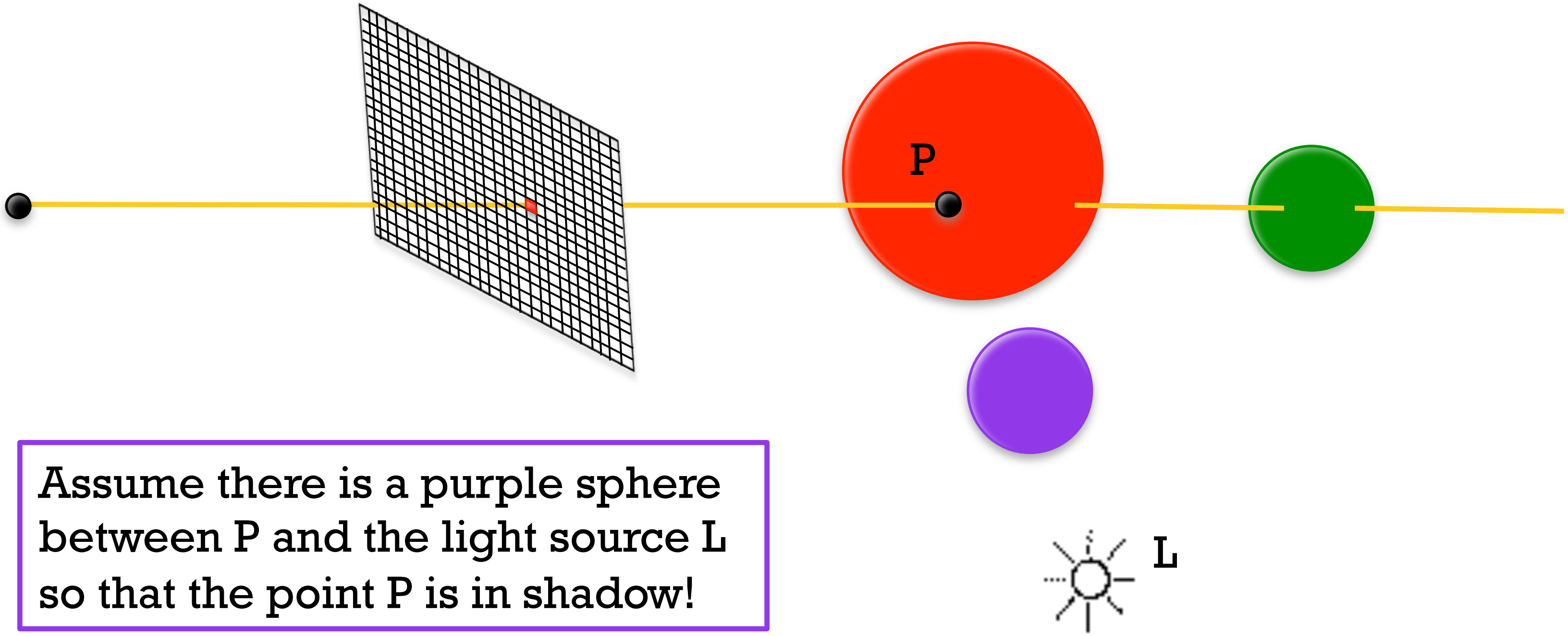
- Diffuse component
- Ambient component

Ray tracing

RayTracer klasse

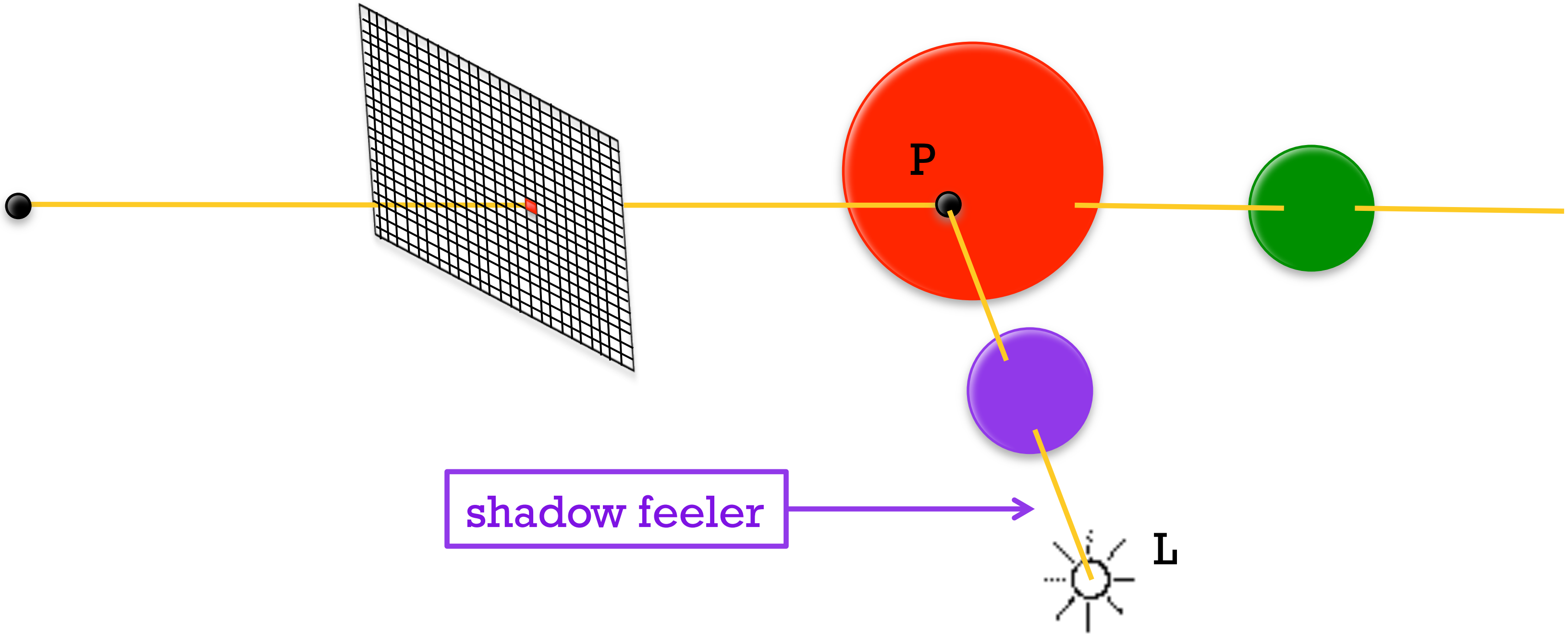
```
private Colour shadeHit(Ray ray, Intersection best) {

        Colour colour = new Colour();

        for all lights in the scene {
                add the ambient component to the colour
                add the diffuse component to the colour
        }
        return colour;

}
```

Ray tracing



Assume there is a purple sphere between P and the light source L so that the point P is in shadow!

Ray tracing



How can we know the hitPoint P is in shadow?

Cast a ray with

- *start: hitPoint P*
- *dir: the vector from P to L*

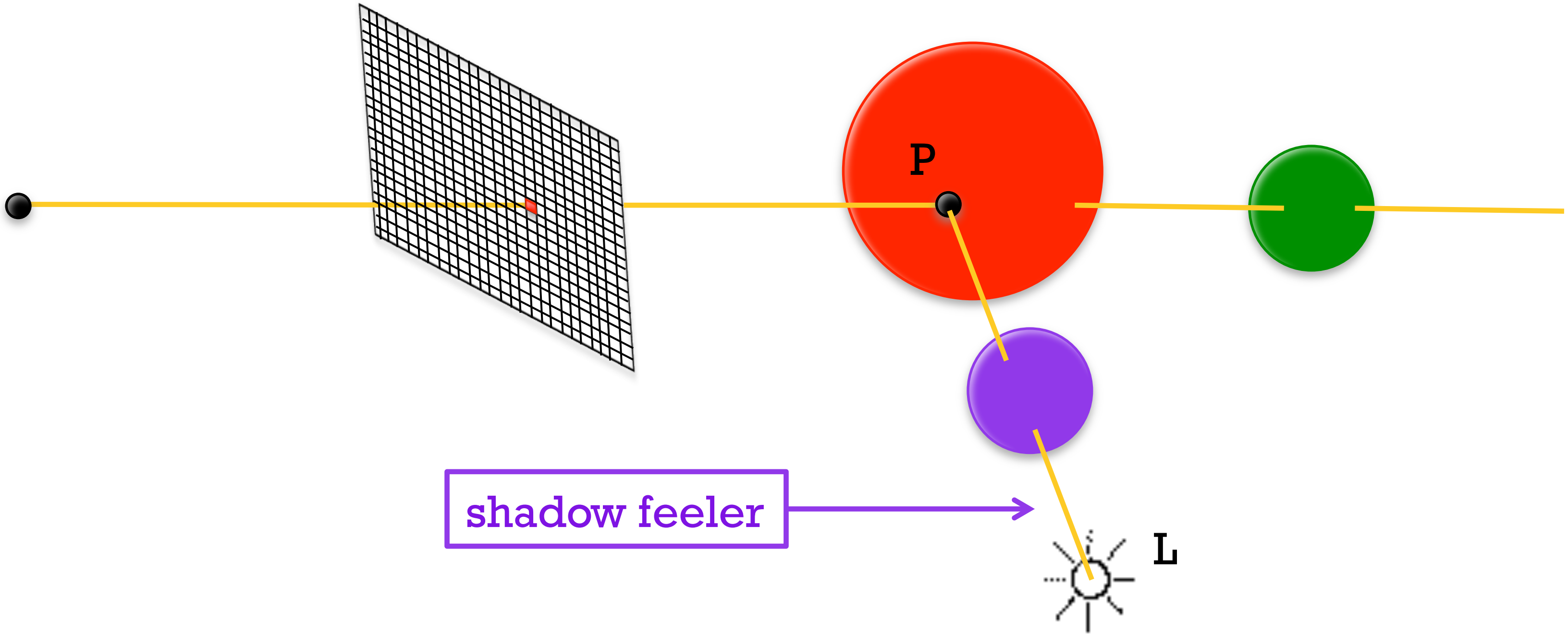
and check whether it intersects with an object in the scene.

Ray tracing and shadows

```
private Colour shadeHit(Ray ray, Intersection best) {

        Colour colour = new Colour();
        Create a shadow feeler and set its start point

        for all lights in the scene{
                add the ambient component to the colour
                compute and set the direction of the shadow feeler
                if(not in shadow){
                        add the diffuse component to the colour
                }
        }
        return colour;
}
```

How will we carry out the check "not in shadow"?

Ray tracing



shadow feeler

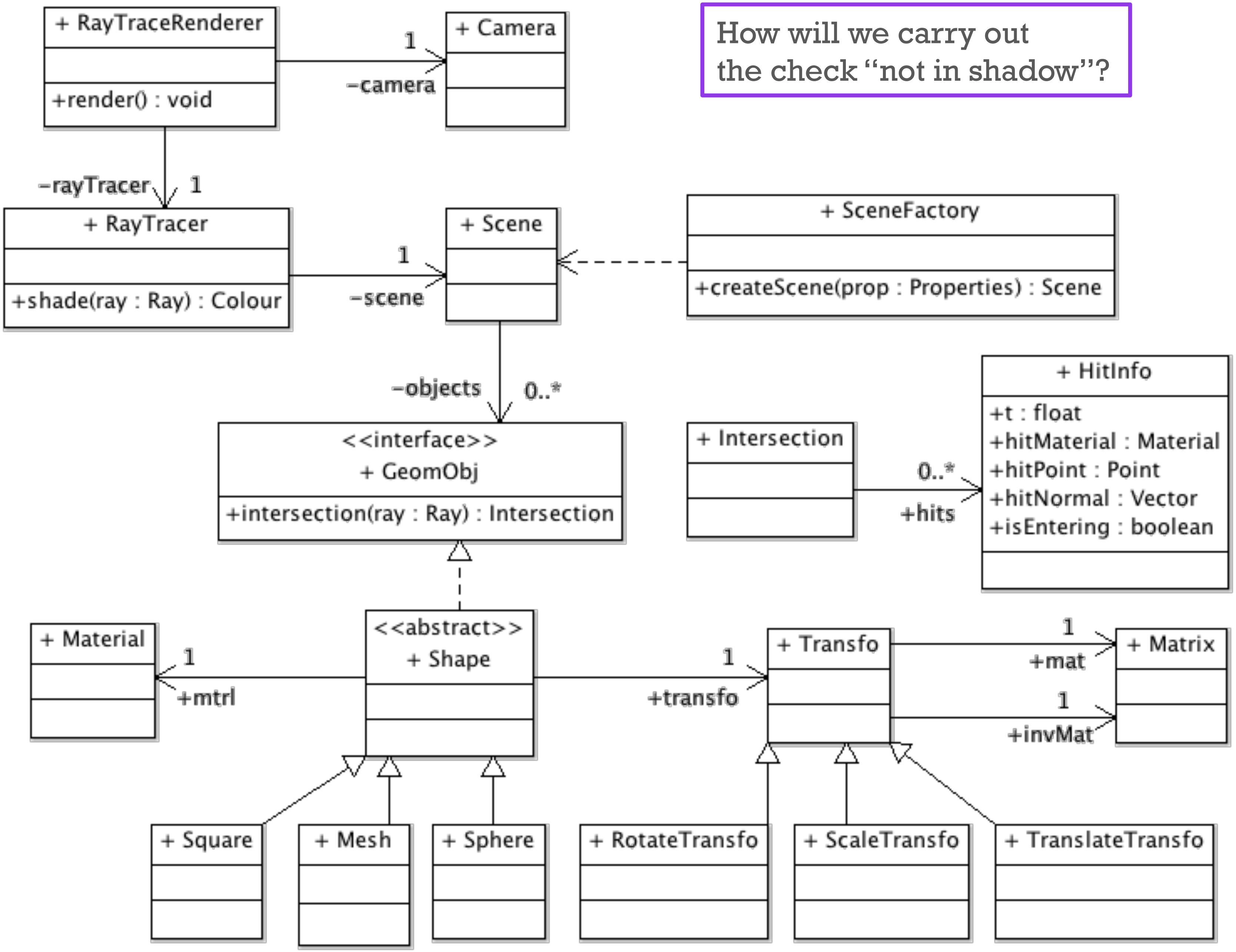
How can we know the hitPoint P is in shadow?

Cast a ray with

- *start: hitPoint P*
- *dir: the vector from P to L*

and check whether it intersects with an object in the scene.

How will we carry out the check “not in shadow”?

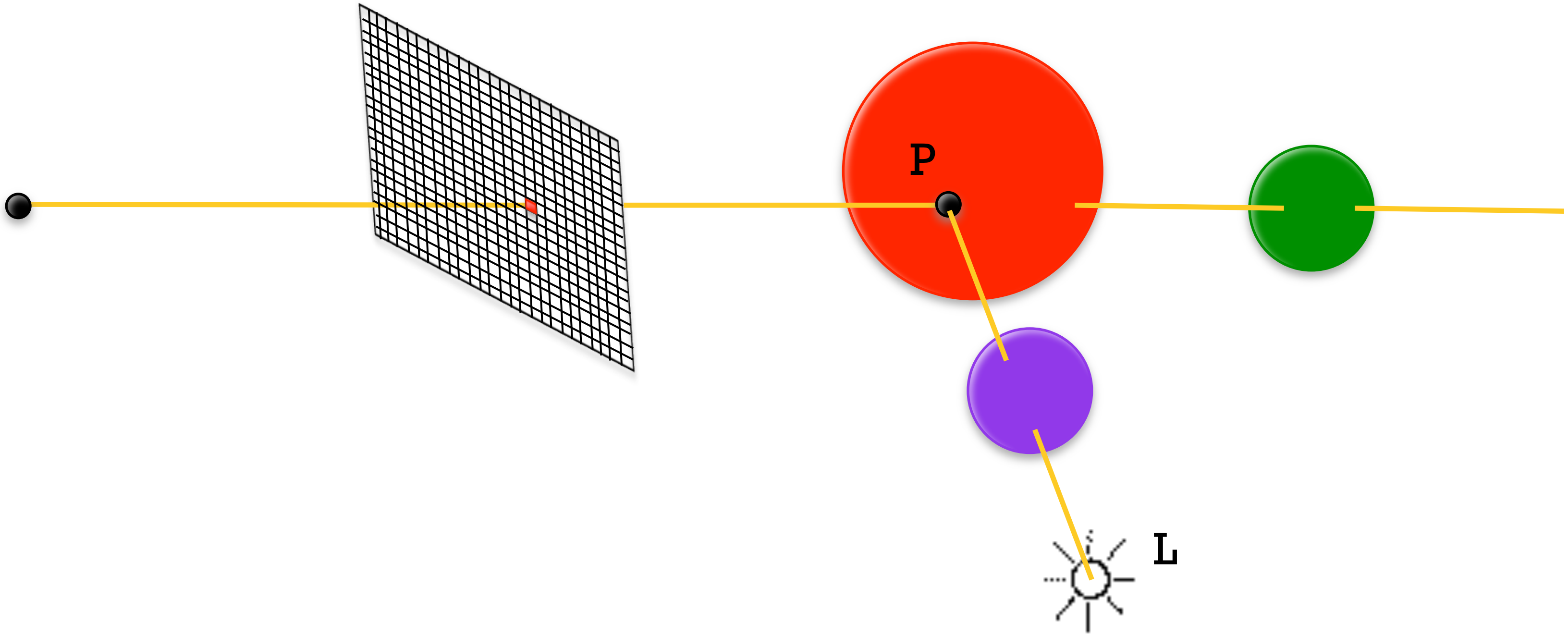


Ray tracing and shadows

- We CANNOT use the intersection method of the GeomObj interface to determine whether a shadow feeler intersects an object in the scene because the t-value should not only be larger than zero but also smaller than one.

Why?

Ray tracing



How can we know the hitPoint P is in shadow?

Cast a ray with

- *start: hitPoint P*
- *dir: the vector from P to L*

and check whether it intersects with an object in the scene.

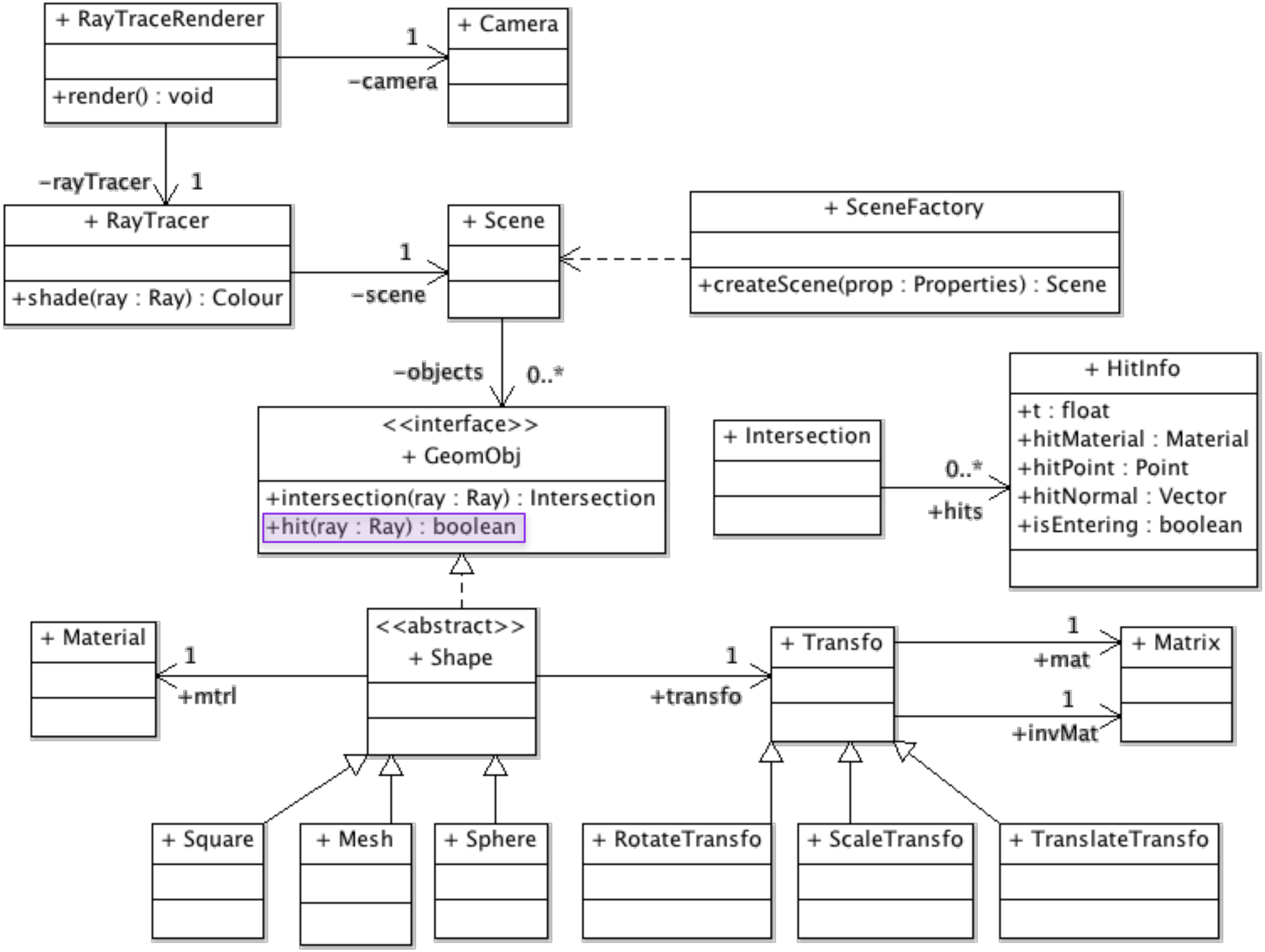
Ray tracing and shadows

- We CANNOT use the intersection method of the RayTraceable interface to determine whether a shadow feeler intersects an object in the scene because the t-value should not only be larger than zero but also smaller than one.

Why?

- Moreover, it would be inefficient to use this intersection method as we don't need all the intersection data returned by this method. We only need a boolean indicating whether there is an intersection or not.

```
public interface GeomObj {
        public Intersection intersection(Ray ray);
        public boolean hit(Ray ray);

}
```



+ RayTraceRenderer
+render() : void

1
−camera

+ Camera

−rayTracer 1

+ RayTracer
+shade(ray : Ray) : Colour

1
−scene

+ Scene

+ SceneFactory
+createScene(prop : Properties) : Scene

−objects 0..*

<<interface>>
+ GeomObj
+intersection(ray : Ray) : Intersection
+hit(ray : Ray) : boolean

+ Intersection

0..*
+hits

+ HitInfo
+t : float
+hitMaterial : Material
+hitPoint : Point
+hitNormal : Vector
+isEntering : boolean

+ Material

1
+mtrl

<<abstract>>
+ Shape

1
+transfo

+ Transfo

1
+mat

1
+invMat

+ Matrix

+ Square

+ Mesh

+ Sphere

+ RotateTransfo

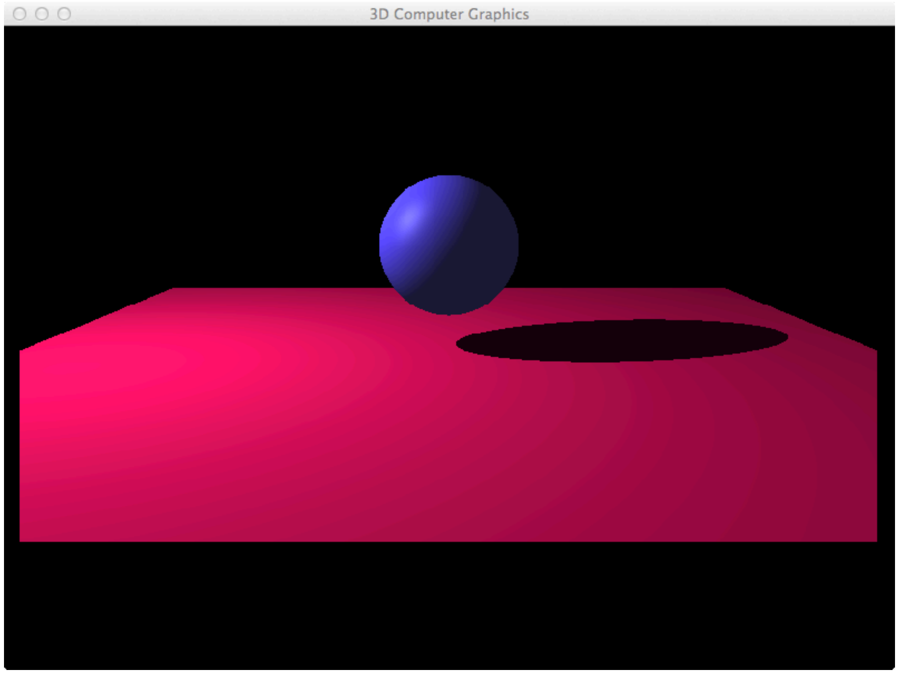
+ ScaleTransfo

+ TranslateTransfo

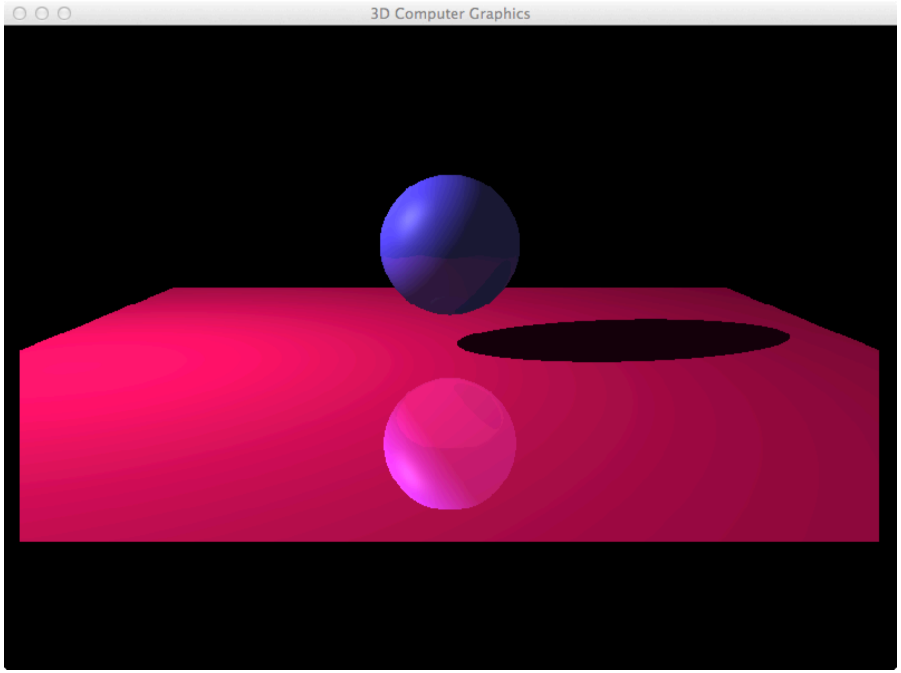
Questions?

Mirrors

Before …



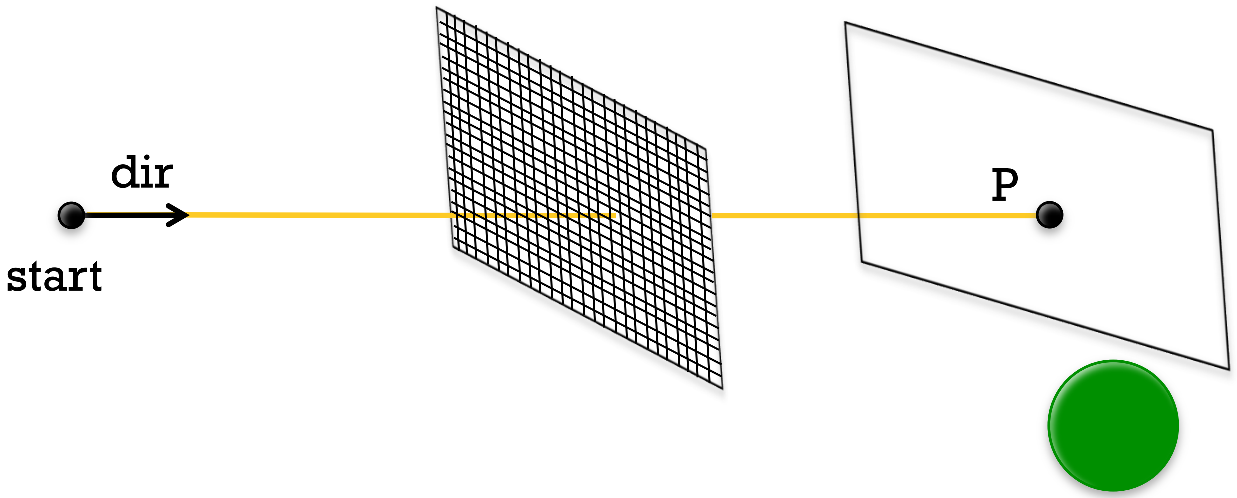
After …



Ray tracing and mirrors

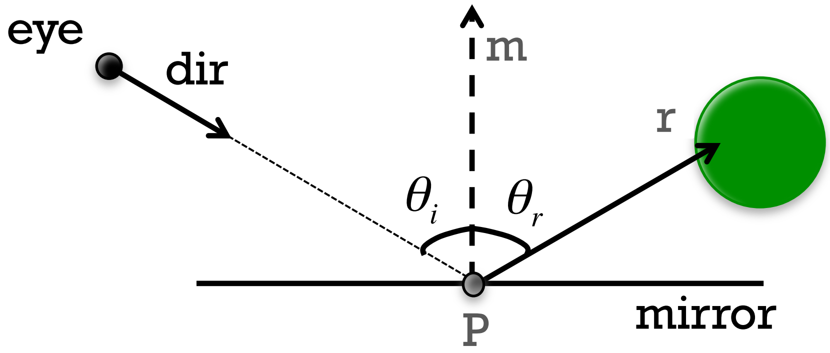
The colour at P:

- Diffuse component
- Ambient component



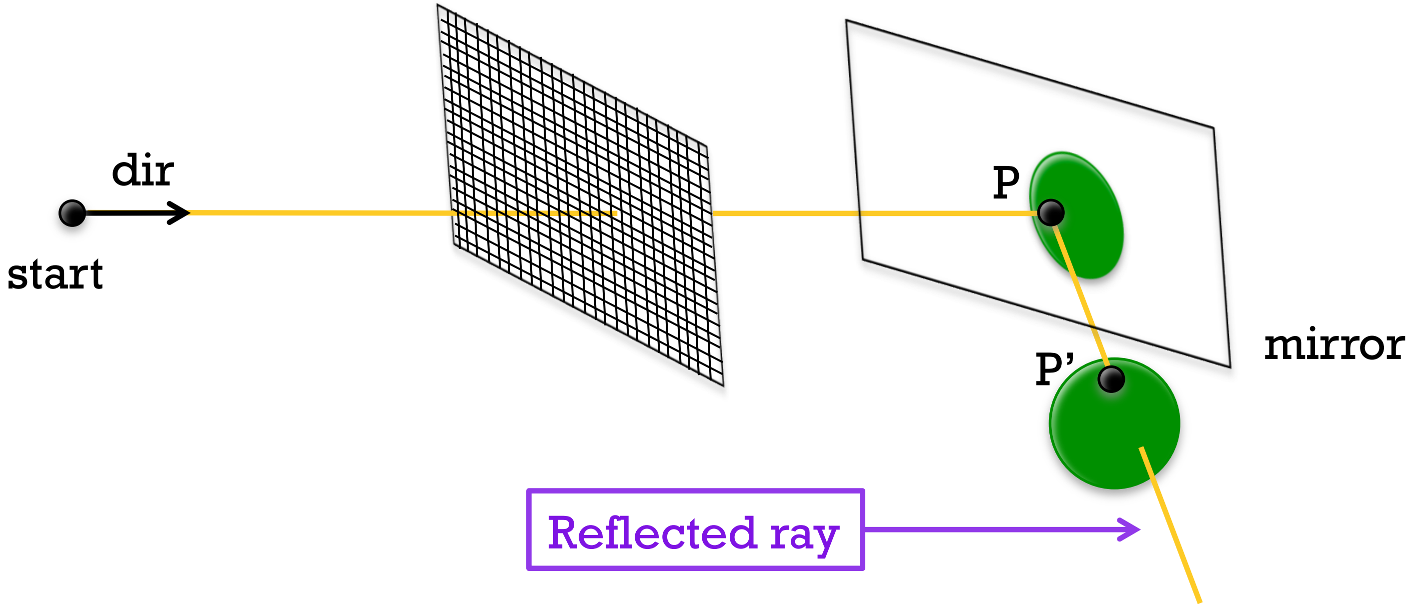
The green sphere is not visible in the image unless the white rectangular object is a mirror…

Ray tracing and mirrors



Mirror reflection direction

$$r = dir - 2\frac{dir.m}{|m|^2}m$$

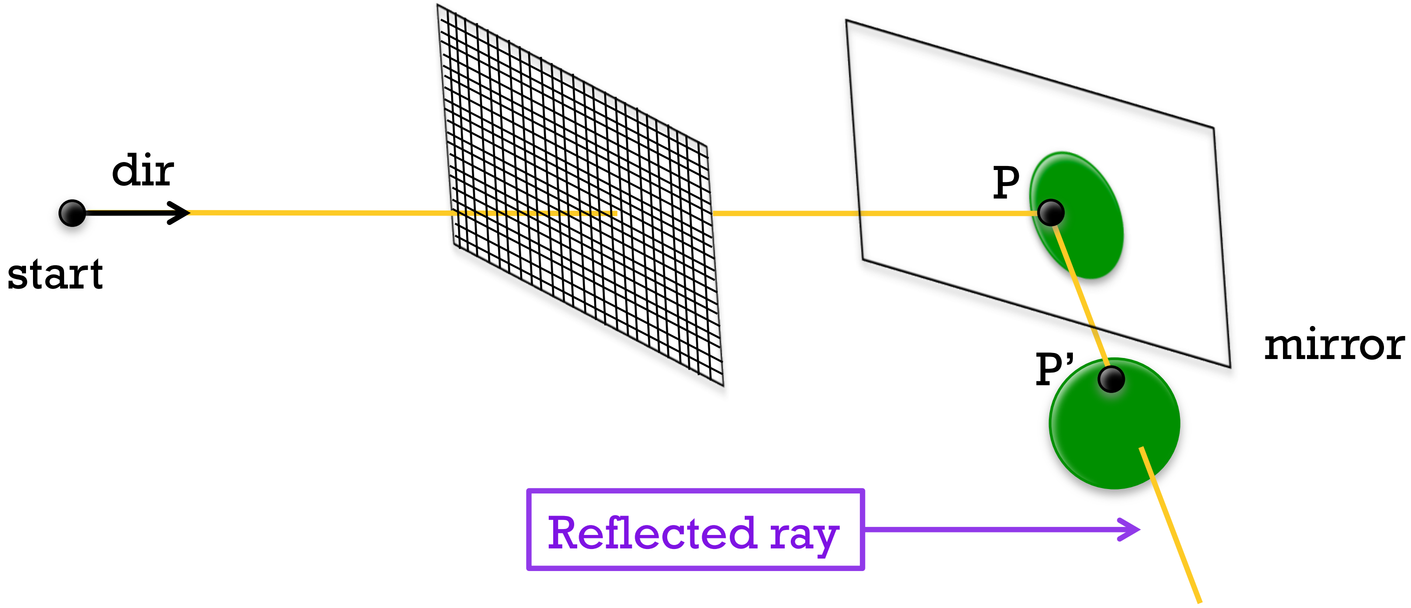


Reflected ray

Ray tracing and mirrors

The colour at P:

- Diffuse component
- Ambient component
- Reflected light component



Reflected ray

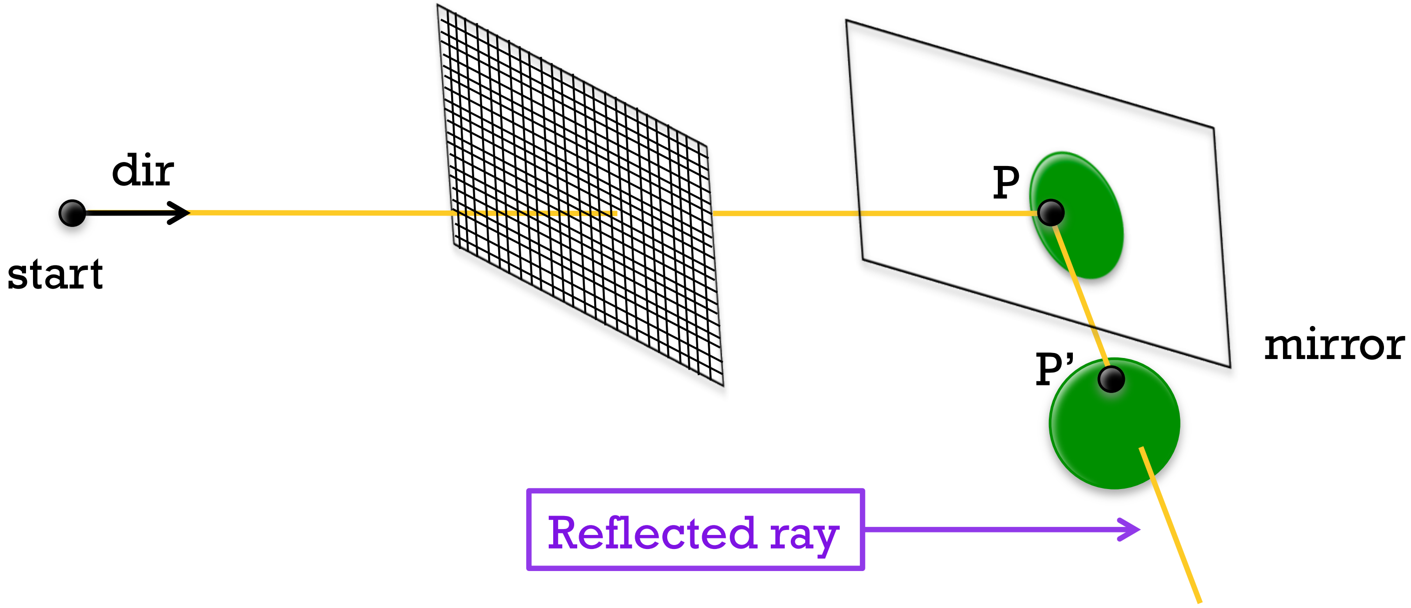
Ray tracing and mirrors

How can we compute P'?

P' is the closest intersection point of the reflected ray with all the objects in the scene.

How can we compute the colour of P'?

Apply again the shading model!



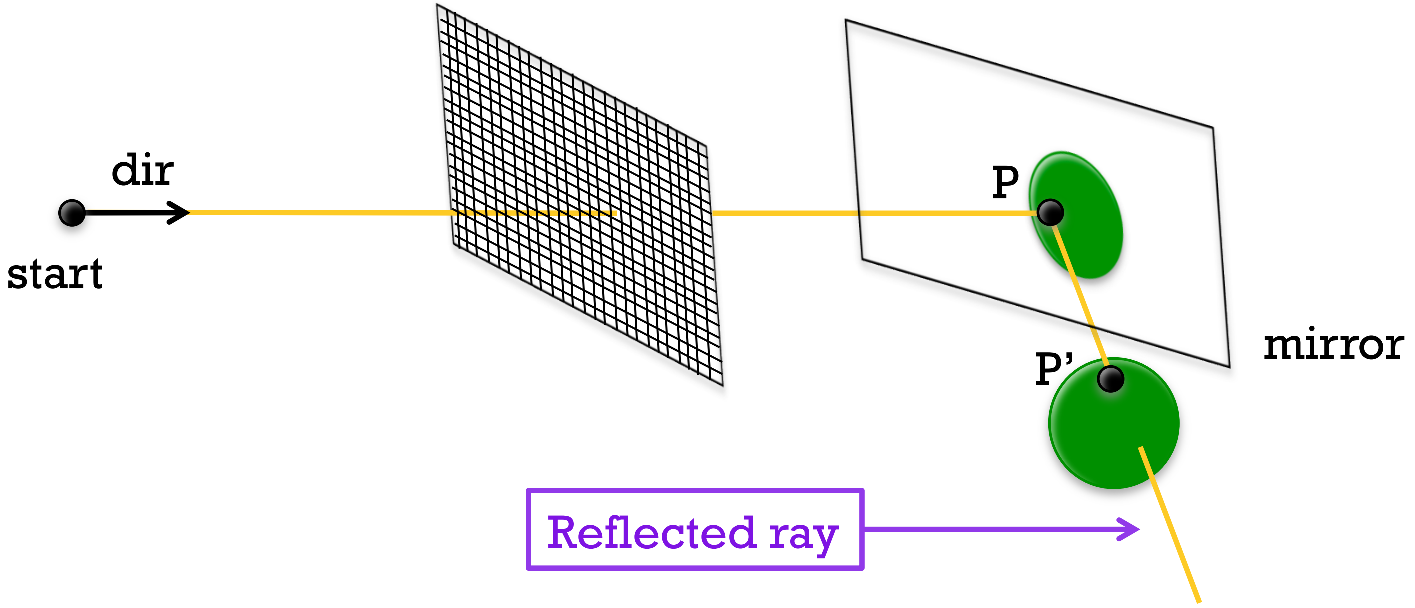
Ray tracing and mirrors

The colour at P':

- Diffuse component
- Ambient component
- Reflected light component?

Yes, if the green sphere also has mirror-like behaviour!

Recursion!



Reflected ray

Ray tracing and mirrors

```
private Colour shadeHit(Ray ray, Intersection best) {

        Colour colour = new Colour();
        Create a shadow feeler and set its start point

        for all lights in the scene{
                add the ambient component to the colour
                compute and set the direction of the shadow feeler
                if(not in shadow){
                        add the diffuse component to the colour
                }
        }
        if(recursionDepth <= maxRecursionDepth and hitObject mirror-like){
                compute the reflected ray
                add the reflected light component to the colour
        }
        return colour;

}
```

Questions?