Photon mapping: starter code

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Starter code basics

- Prerequisite for photon mapping: ray tracer
- We are providing you with some starter code
- Various parts of this code are by
  - University of Washington graphics group
  - Henrik Wann Jensen
  - Me (Chris Twigg)

What’s in there?

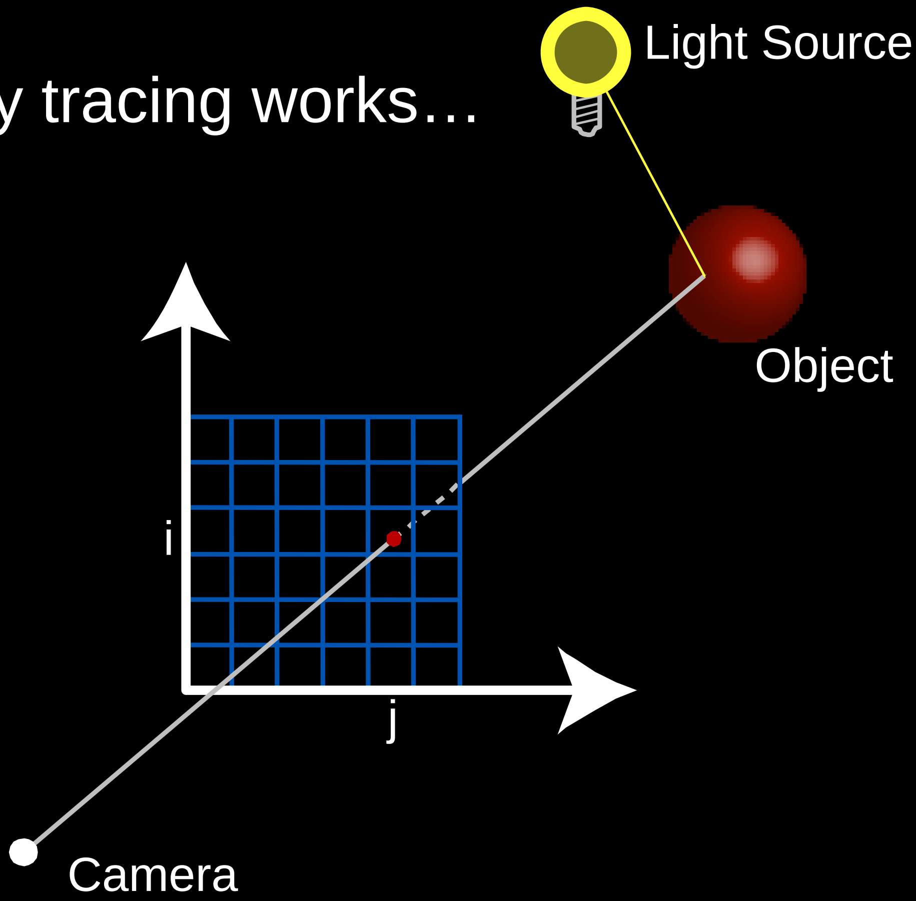
- Full Whitted-style ray tracer, supports
  - Arbitrary polymesh geometry
  - AABB acceleration
  - Texture mapping
  - Antialiasing using distributed rays
- User interface for visualizing scenes
- Completely portable code, we support both Windows and Linux

Directory Structure

- **src/**
  - **fileio/ :** utility stuff for the parser
  - **parser/ :** parsing of .ray files
  - **scene/ :** scene graph, shading, lighting
  - **SceneObjects/ :** geometry & intersection
  - **ui/ :** user interface (graphical and command-line)
  - **vecmath/ :** wrappers for the VL library
- **scenes/ :** sample scenes

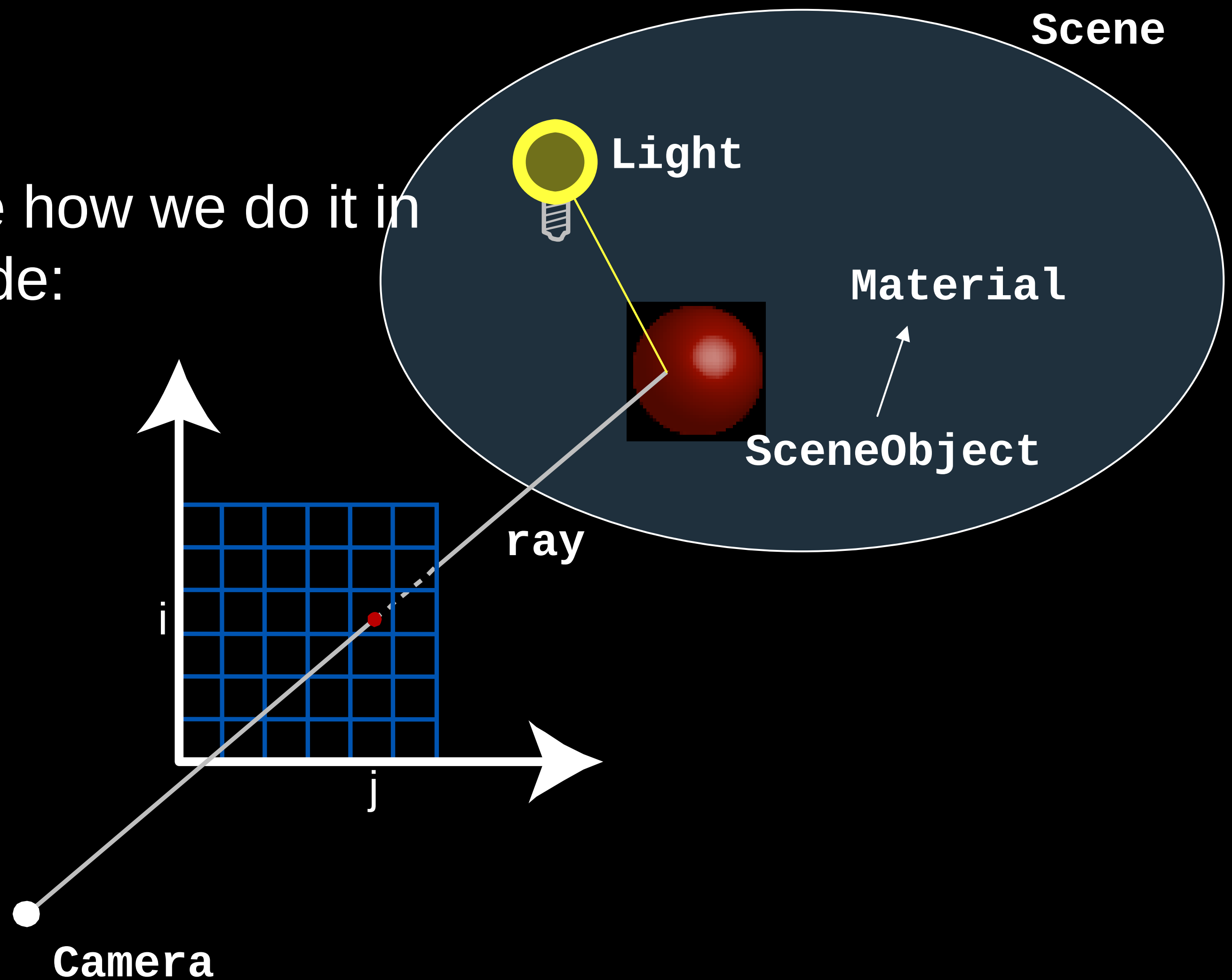
Visual Code Overview

Recall how ray tracing works…



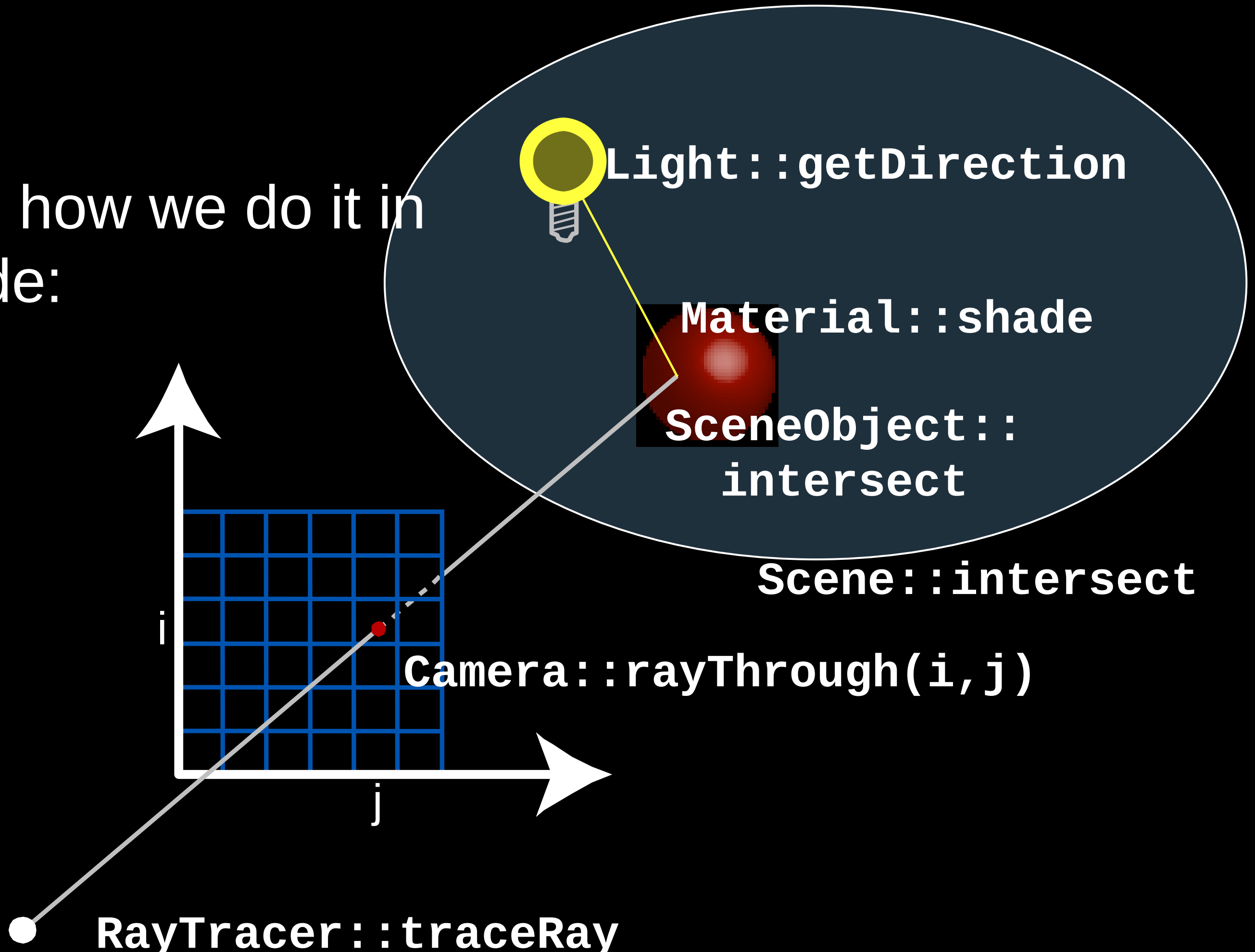
Visual Code Overview

Now, let's see how we do it in the starter code:

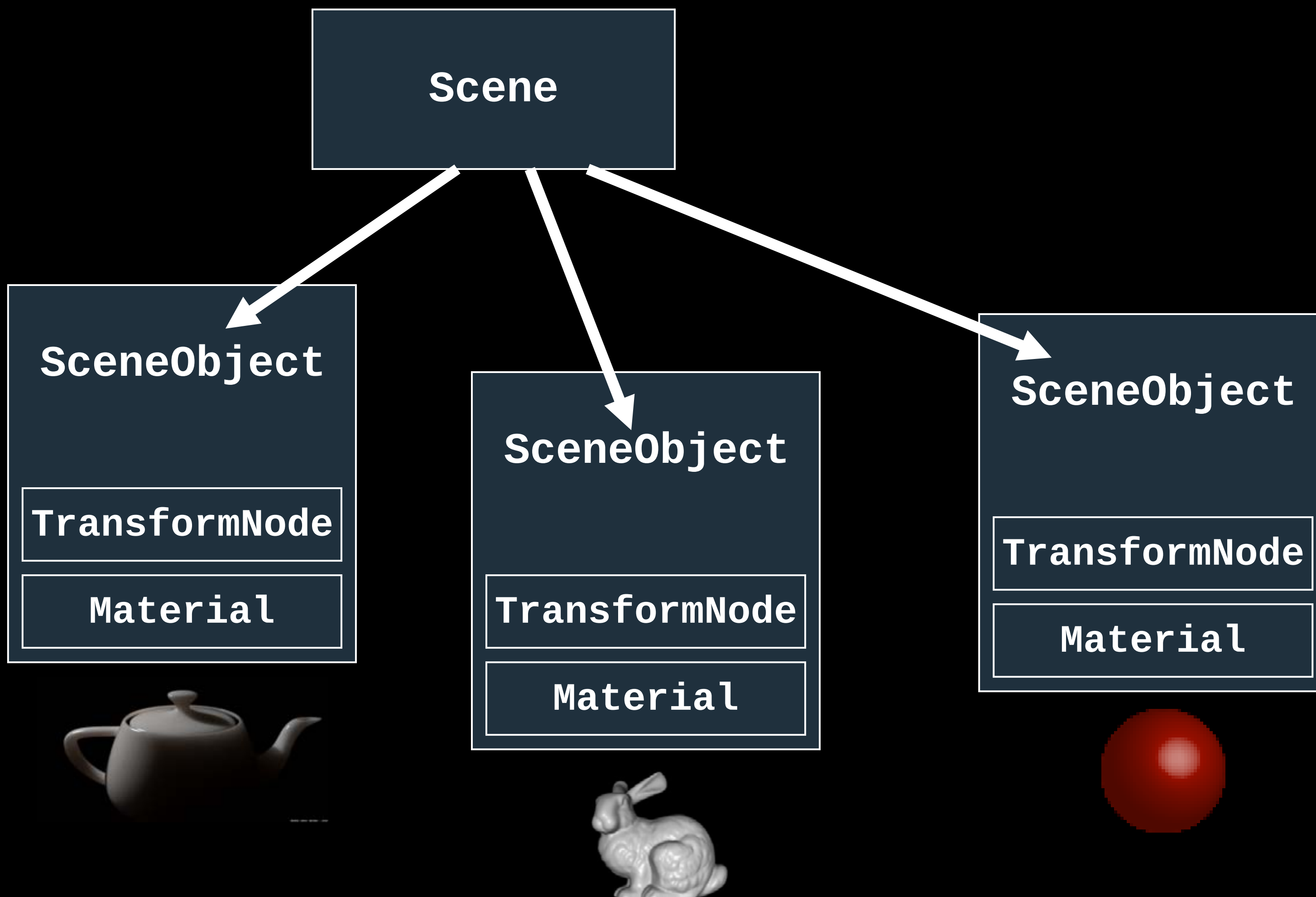


Visual Code Overview

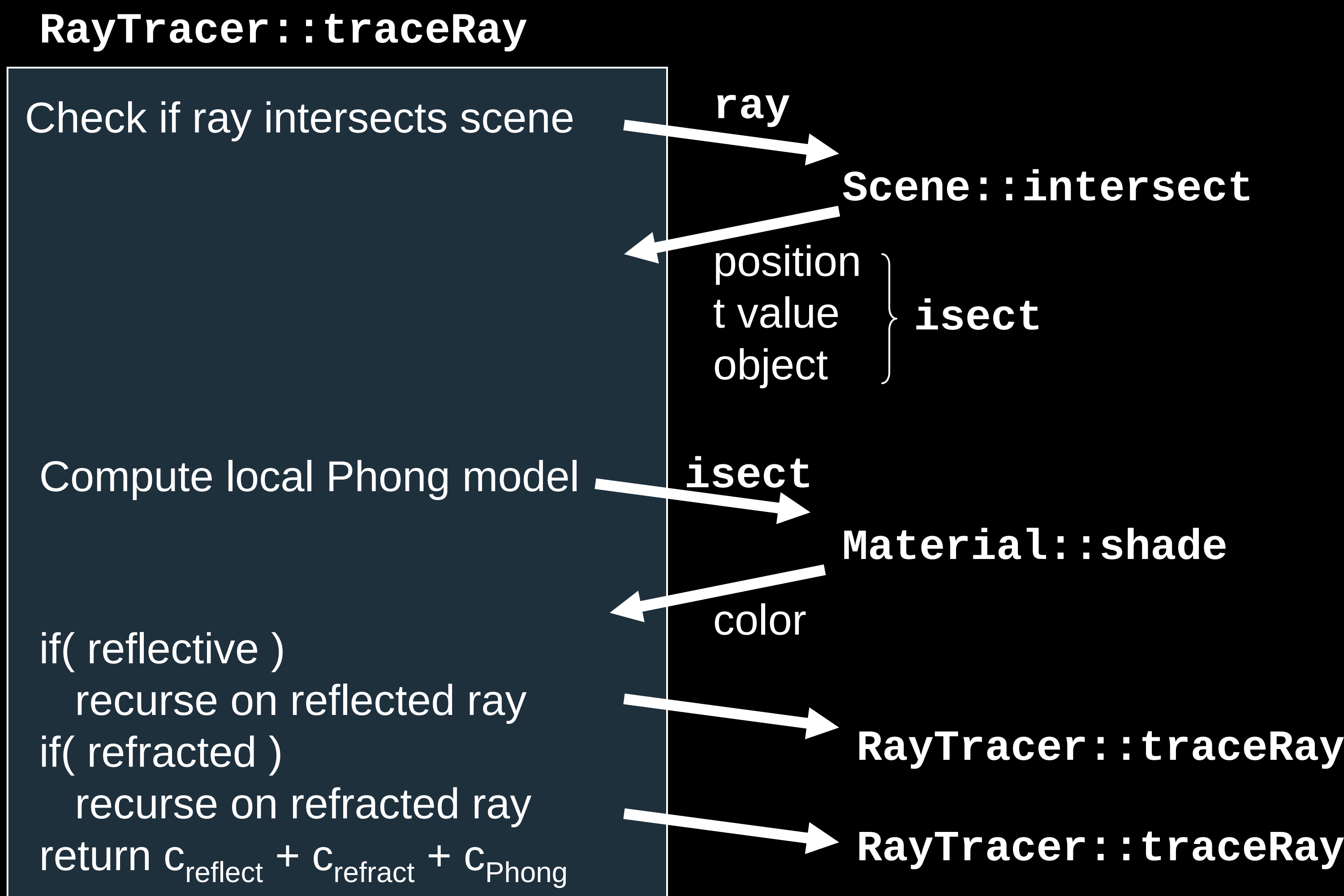
Now, let's see how we do it in the starter code:



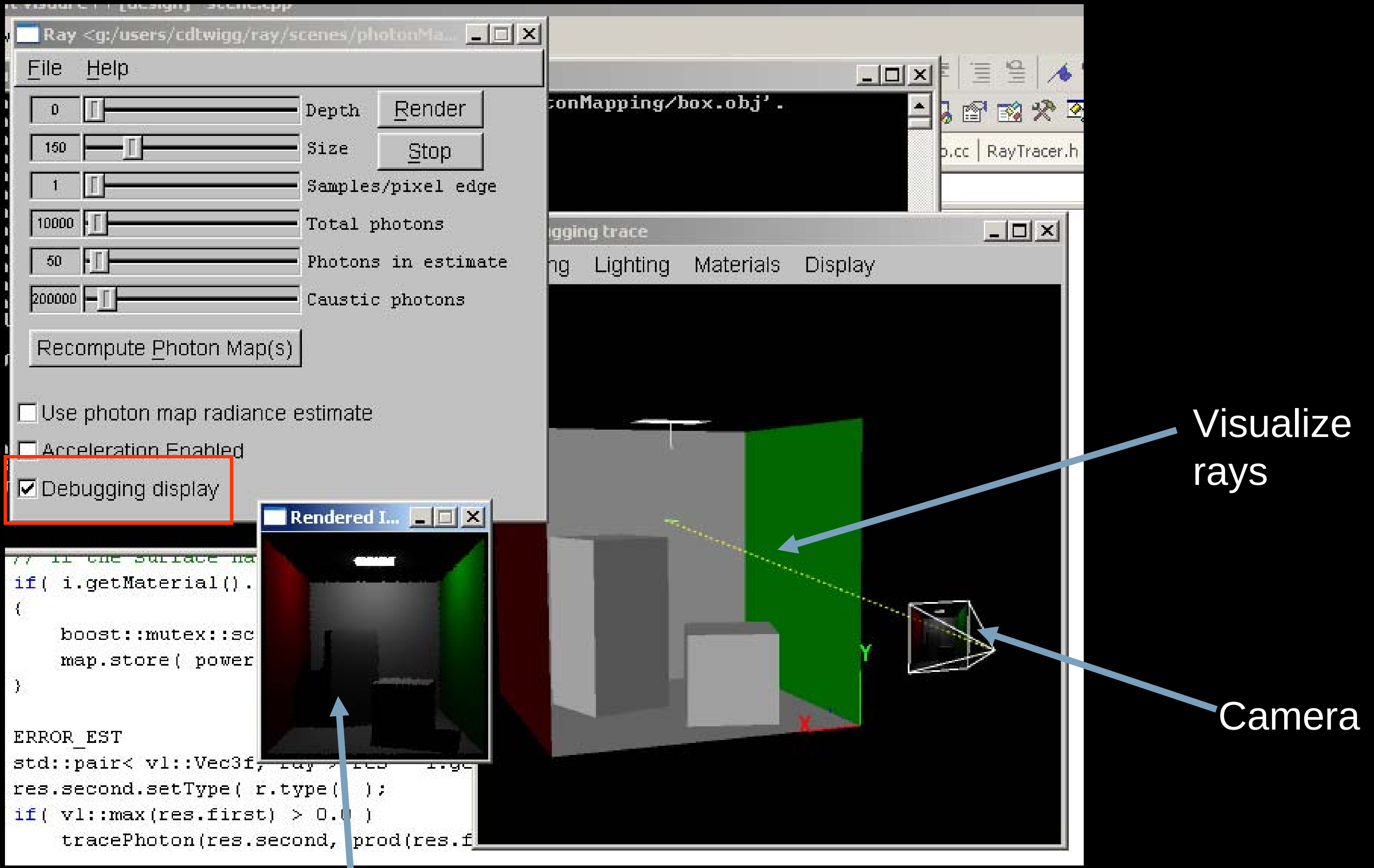
The scene graph



Tracing rays…



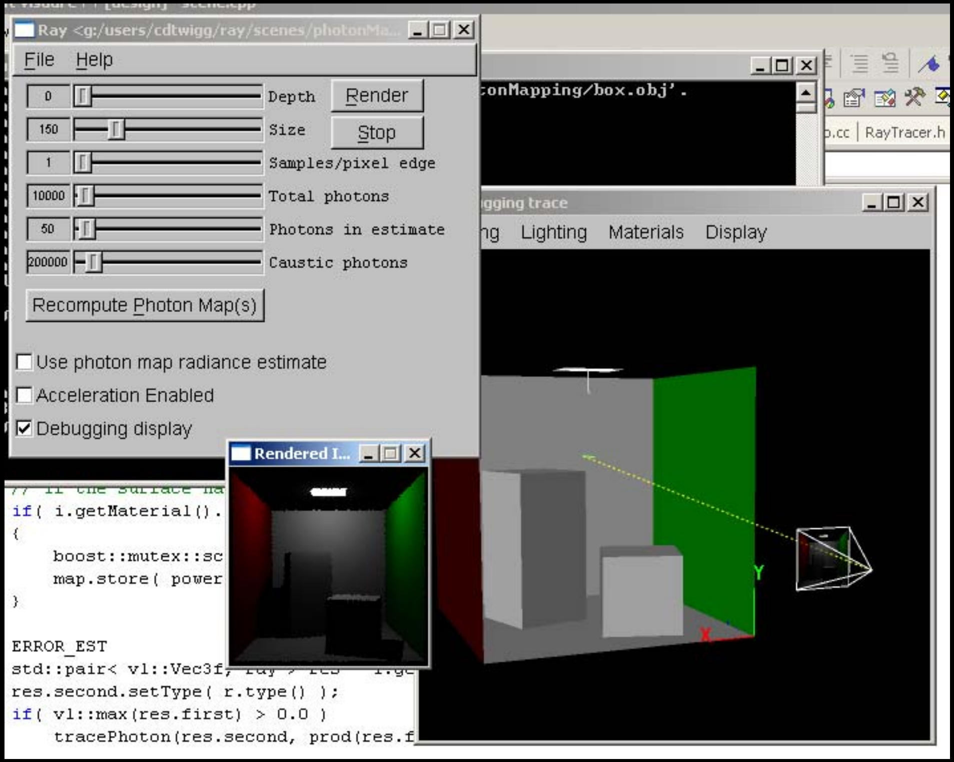
User Interface



Clicking here traces a single ray through the scene, so you can set breakpoints, etc.

User Interface

- Think of creative ways to use the interface
- Visual debugging is a useful skill in graphics…



Implementing: soft shadows

- For soft shadows, we need to distribute our shadow rays over the light source area
- A square with emissivity is our only area light source:

```
// light
translate( 2.78, 5.48, 2.295,
          scale( 1.3, 1.0, 1.05,
                    rotate( 1.0, 0.0, 0.0, 1.5708,
                    square {
                              material = {
                                        emissive = (250.0, 250.0, 250.0);
                                        diffuse = (0.750, 0.750, 0.750);
                              }
          } ) ) )
```

Implementing: soft shadows

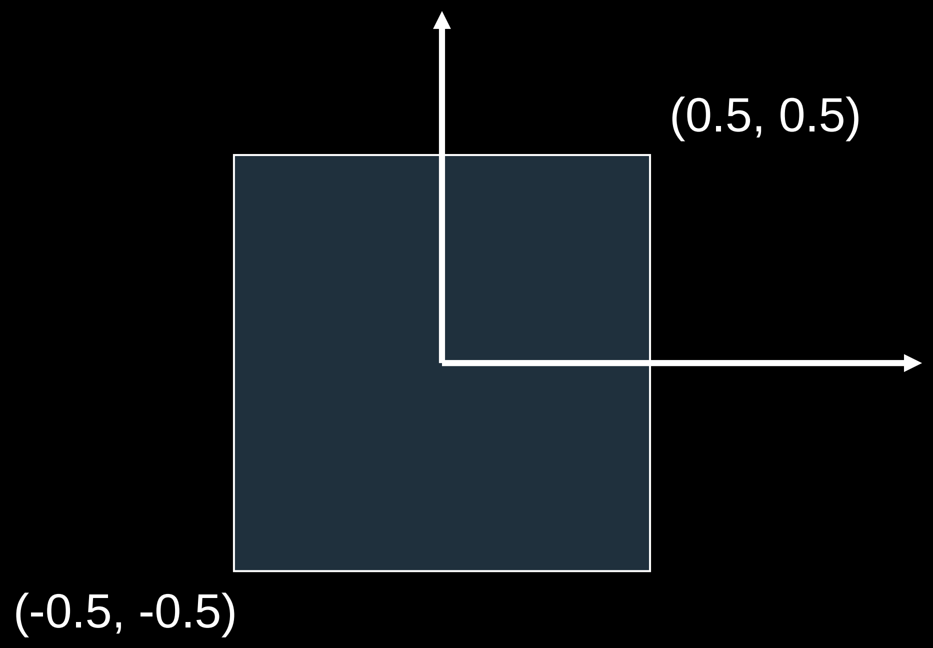
- Right now, **`Square::getDirection`** acts like a point light:

```
LightProperties Square::getDirection(
        const Vec3f& P,
        unsigned int index ) const
{
        // Treat it like a point light
        vl::Vec3f position = transform
                ->localToGlobalCoords(vl::Vec3f(0,0,0));
        Vec3f d = (position-P);
        float dL = len(d);
        d /= dL;
        float t = dot(position - P, d);
        float falloff = 1.0/(4*pi*dL*dL);
        return LightProperties(
                ray(P, d, index, ray::SHADOW),
                t, falloff );
}
```

Implementing: soft shadows

Points on the square are defined in *local* coordinates

We use **`transform->localToGlobalCoords`** coordinates to get worldspace coords



Implementing: photon maps

- **`Scene::recomputePhotonMaps`** is called before any rays are traced
- Can access photon map from within **`Material::shade`** (use the **`Scene*`** that is passed in)

Implementing: photon maps

- Henrik's photon map implementation (from the book) is included (class **`Photon_map`**)
- Key functions:
  - **`store`**: store a photon in the map
  - **`scale_photon_power`**: scale all photons (since last time function called) by same value
  - **`balance`**: balance the kd-tree, must be called *after* all photons are stored but *before* obtaining any irradiance estimates
  - **`irradiance_estimate`**

Implementing: photon maps

Pseudocode:

```
foreach Light* L
{
  for( i = 1 to nPhotons )
  {
    {power, position, direction} =
      trace_photon( L, L->randomDir(), L->color() );
    photonMap_->store( power, position, direction );
  }

  photonMap_->scale_photon_power( 1.0/nPhotons );
}

photonMap_->balance();
```

Useful functions

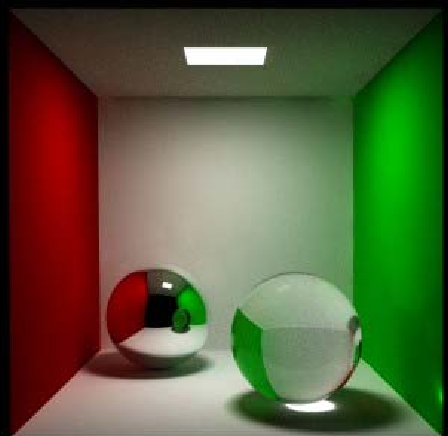
- Sources of randomness:
  - **`RayTracer::uniform01()`**
  - **`RayTracer::uniformOnSphere()`**
  - **`RayTracer::uniformInt(N)`**
- Note: Can access these from anywhere with the following syntax
  - **`traceUI->rayTracer().uniform01();`**

Sample scenes

Soft shadows
Global illum.

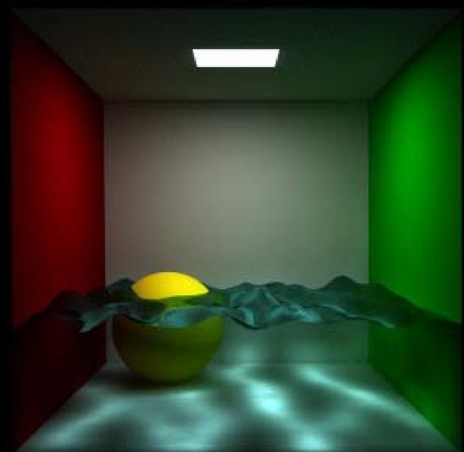
cornellBox.ray

+refractive caustic
(sphere only)



cornellBoxSpheres.ray

+refractive caustic
(arbitrary geom.)



cornellBoxWater.ray

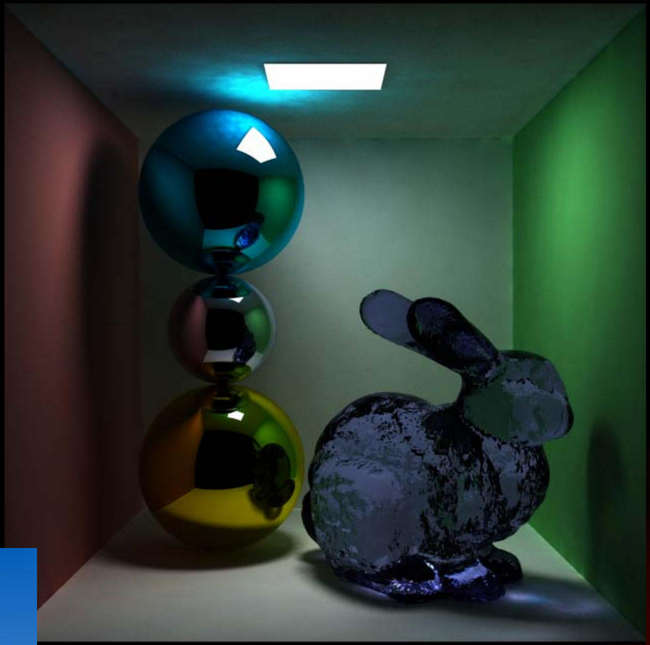
+reflective caustic
(arbitrary geom.)

cornellBoxReflective.ray

probably optional
(pending Doug's decision)

easiest → hardest

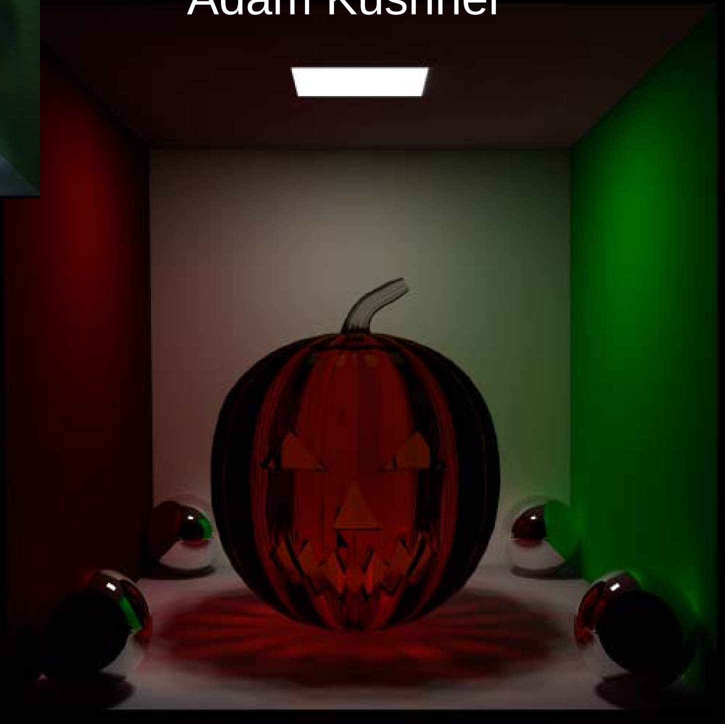
Make your own!



Kris Poppendorf

Jernej Barbic

Adam Kushner



.ray file format

Arbitrary, nested transforms:

```
// light
translate( 2.78, 5.48, 2.295,
      scale( 1.3, 1.0, 1.05,
            rotate( 1.0, 0.0, 0.0, 1.5708,
            square {
                  material = {
                        emissive = (250.0, 250.0, 250.0);
                        diffuse = (0.750, 0.750, 0.750);
                  }
      } ) ) )
```

.ray file format

Scoping is allowed:

```
scale( 0.01, 0.01, 0.01,
      {
            sphere {}
            box {}
      }
```

.ray file format

Arbitrary .obj geometry:

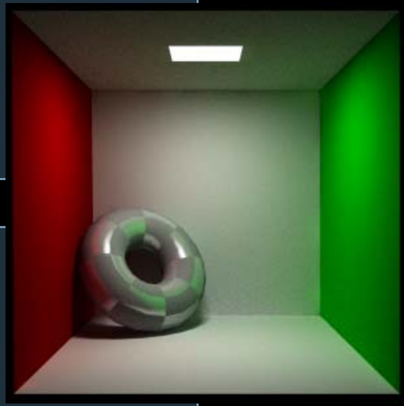
```
polymesh {
	material = {
		diffuse = (0.750, 0.750, 0.750);
	}
	objfile = "box.obj";
	objgroup = "Cube";
}
```

note that you must still specify material params

.ray file format

Texture map any material attribute:

```
polymesh {
        material = {
                // map the diffuse color
                diffuse = map( "checkerboardDark.bmp" );
        }
        objfile = "torus.obj";
        objgroup = "pTorus1";
}
```



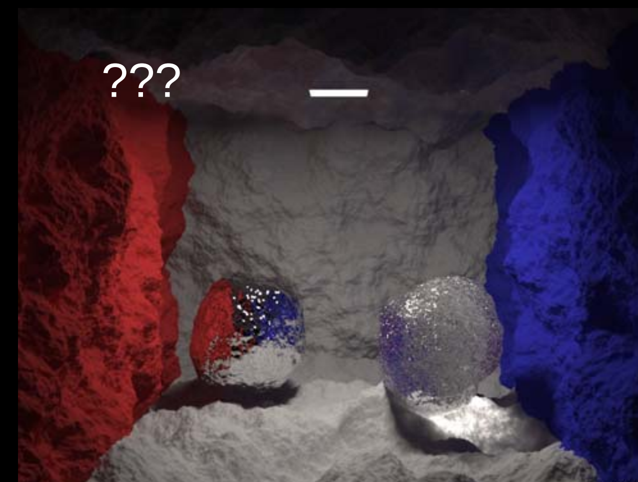
```
 ...
         material = {
                 // map the specular color
                 specular = map( "checkerboardDark.bmp" );
                 shininess = 100;
         }
 ...
```

Many more possibilities…

Be creative!

source: *FACHE Sebastien*

source: Henrik Wann Jensen



source: Henrik Wann Jensen