ICS 186B Advanced Computer Graphics

Final Term Presentation

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Overview

- Global illumination lighting demo, with the following features:
  - Multi-texture mapping (OpenGL, with ARB multi-texture extension)
  - Hardware transforms, blending, depth testing (OpenGL)
  - Direct and indirect illumination (computed lightmaps)
  - Saving / loading of lightmaps
  - Custom map file format

- What is a lightmap?
  - A texture that's generated for each surface
  - Specifies the incident light arriving at each textured point along the surface

- *No viewer dependencies (e.g. specular highlights, reflections)*

We generate two lightmaps per surface: a direct illumination lightmap, and a global illumination lightmap.

Phase 1: Direct illumination (DI):

```
for each triangle in the scene:
   for each lumel (luminance element, i.e. a texel in our DI lightmap):
       compute the world space coordinate for this lumel
       for each light in the scene:
           trace a ray from our lumel to the light
           if ray reaches the light unobstructed, compute irradiance and store it in our DI lightmap
```

$$R_{DI} = \sum_{lights} L_v \bullet S_n * \left(\frac{L_i}{1 + dist^2} \right) * L_c * Occ$$

RDI *: reflected direct luminance*
Lv *: incident unit vector, computed as normalize(light position - lumel position)*
Sn *: surface normal*
Li *: light intensity value*
Dist *: distance from the lumel to the light. Computed as length(light position - lumel position)*
Lc *: light color*
Occ *: occlusion factor. 1 if path from lumel to light is unobstructed, 0 otherwise.*

Phase 2: Global illumination (GI):

```
for each triangle in the scene:
   for each lumel (luminance element, i.e. a texel in our GI lightmap):
       compute the world space coordinate for this lumel
       for i = 0 -> MAX_SAMPLES:
         randomly select a vector on the unit hemisphere about the triangle normal
         trace a ray from our lumel along our random vector
         if ray hits a surface:
           accumulate the direct illumination reflected from the collided surface, asindirect samples
```

$$R_{GI} = \frac{1}{n} \sum_{samples} R_v \bullet S_n * R_c * Occ$$

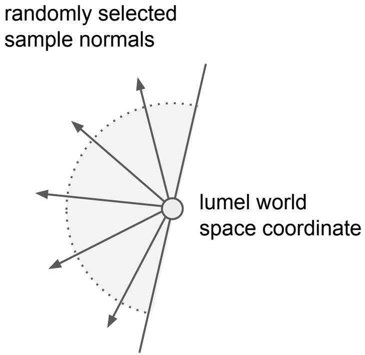
RGI *: reflected global luminance*

Rv *: incident unit vector, randomly generated from the unit hemisphere*

Sn *: surface normal*

Rc *: incident direct illumination color*

Occ *: occlusion factor. 1 if path from lumel to sample point is unoccluded. 0 otherwise.*


randomly selected sample normals
lumel world space coordinate

Combined illumination model:

Combine GI samples to our DI value (from phase 1), and store in our GI lightmap.

$$R = S_c * (RDI + RGI)$$

R *: reflected luminance*

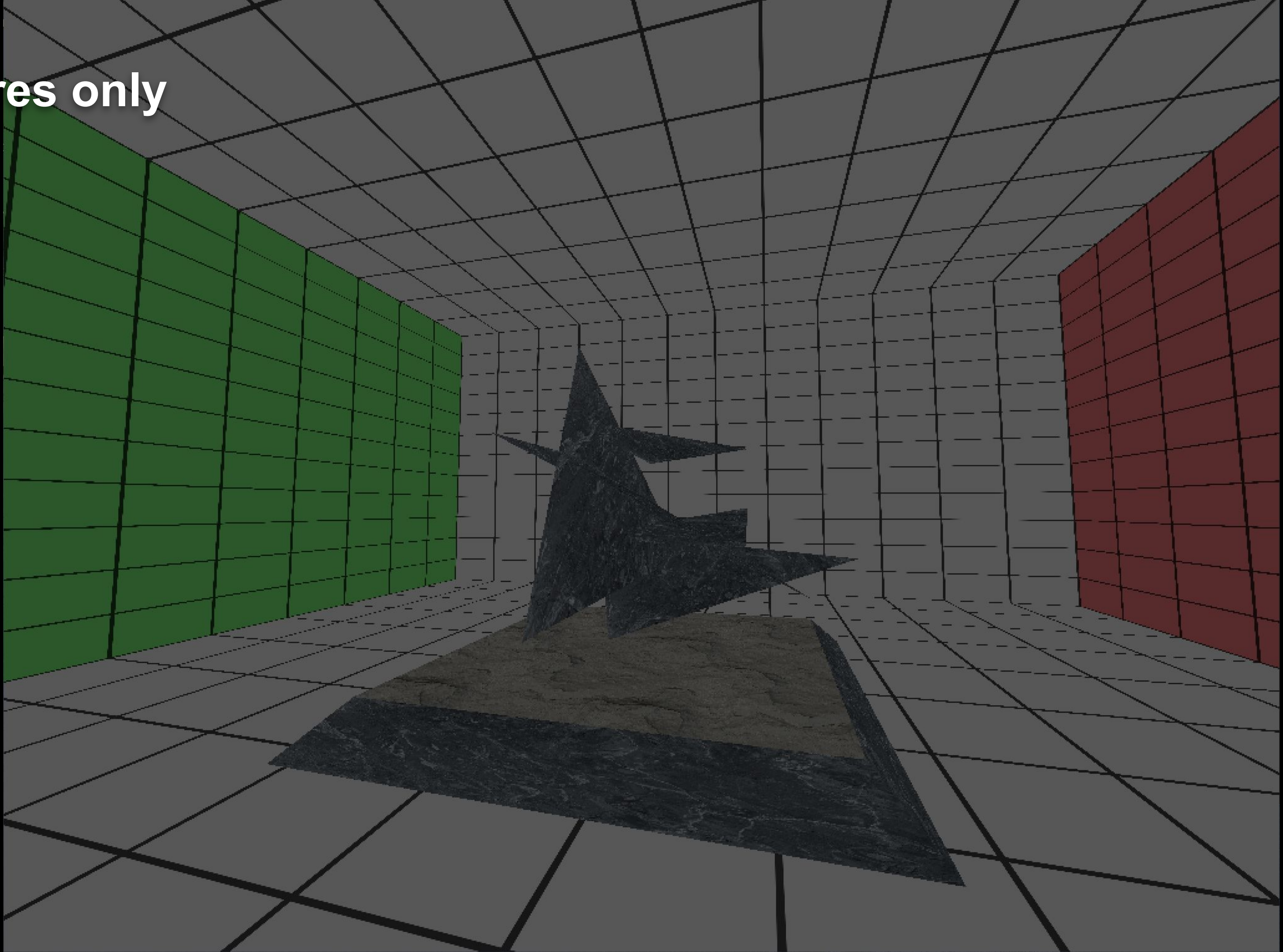
Sc *: surface color at the lumel coordinate*

DI *: direct illumination contribution*

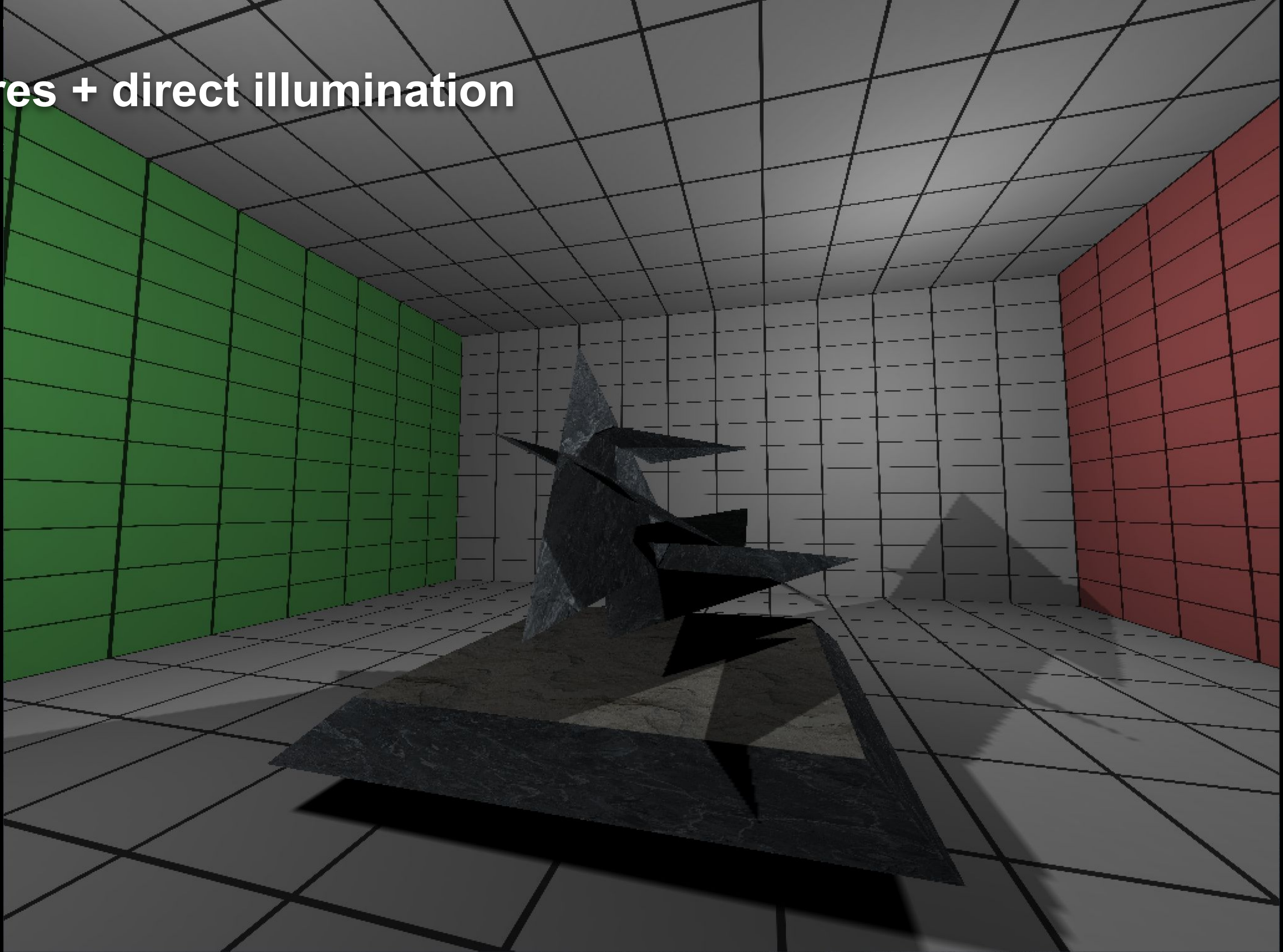
GI *: global illumination contribution*

Example 1

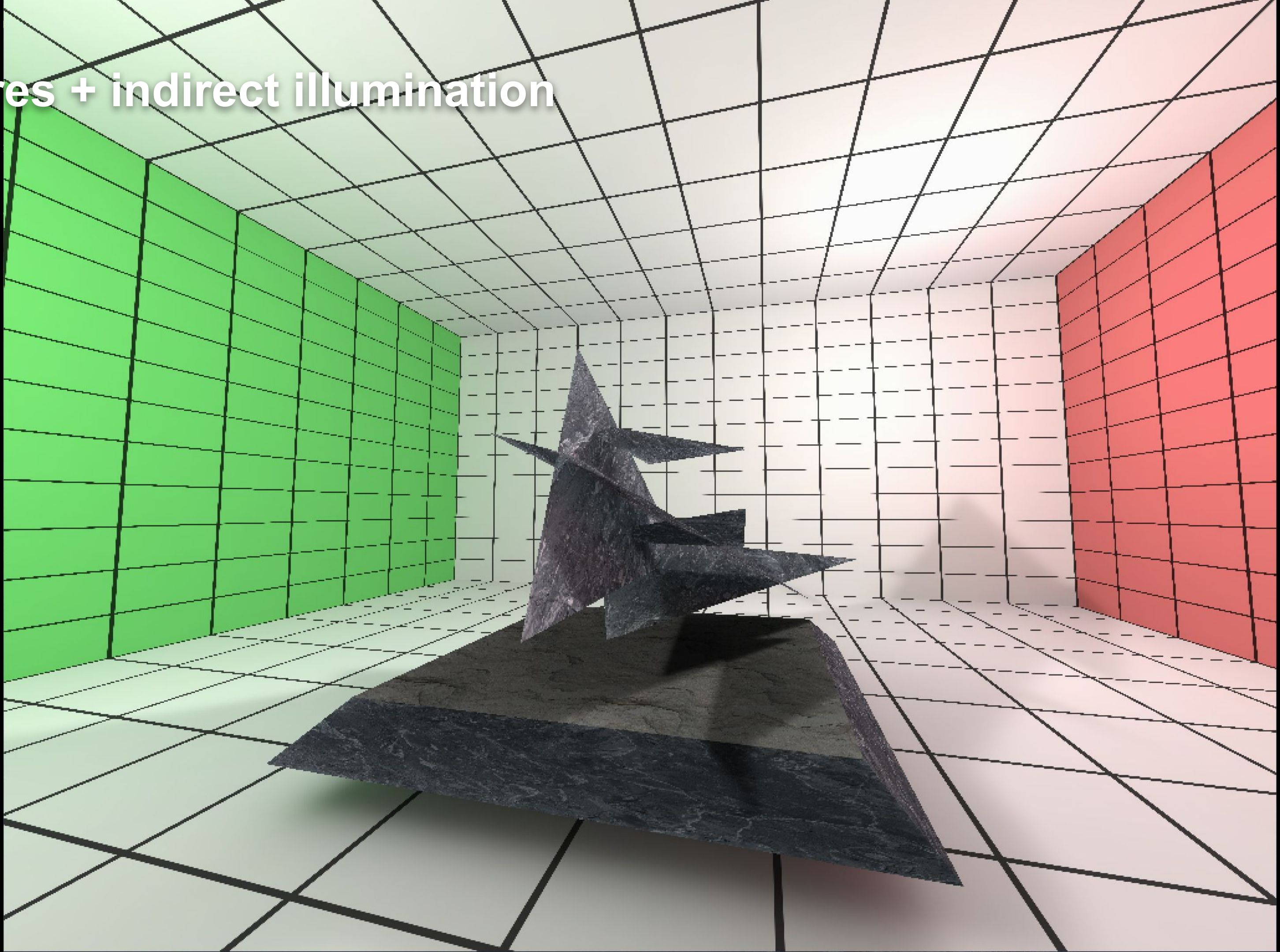
Textures only



Textures + direct illumination

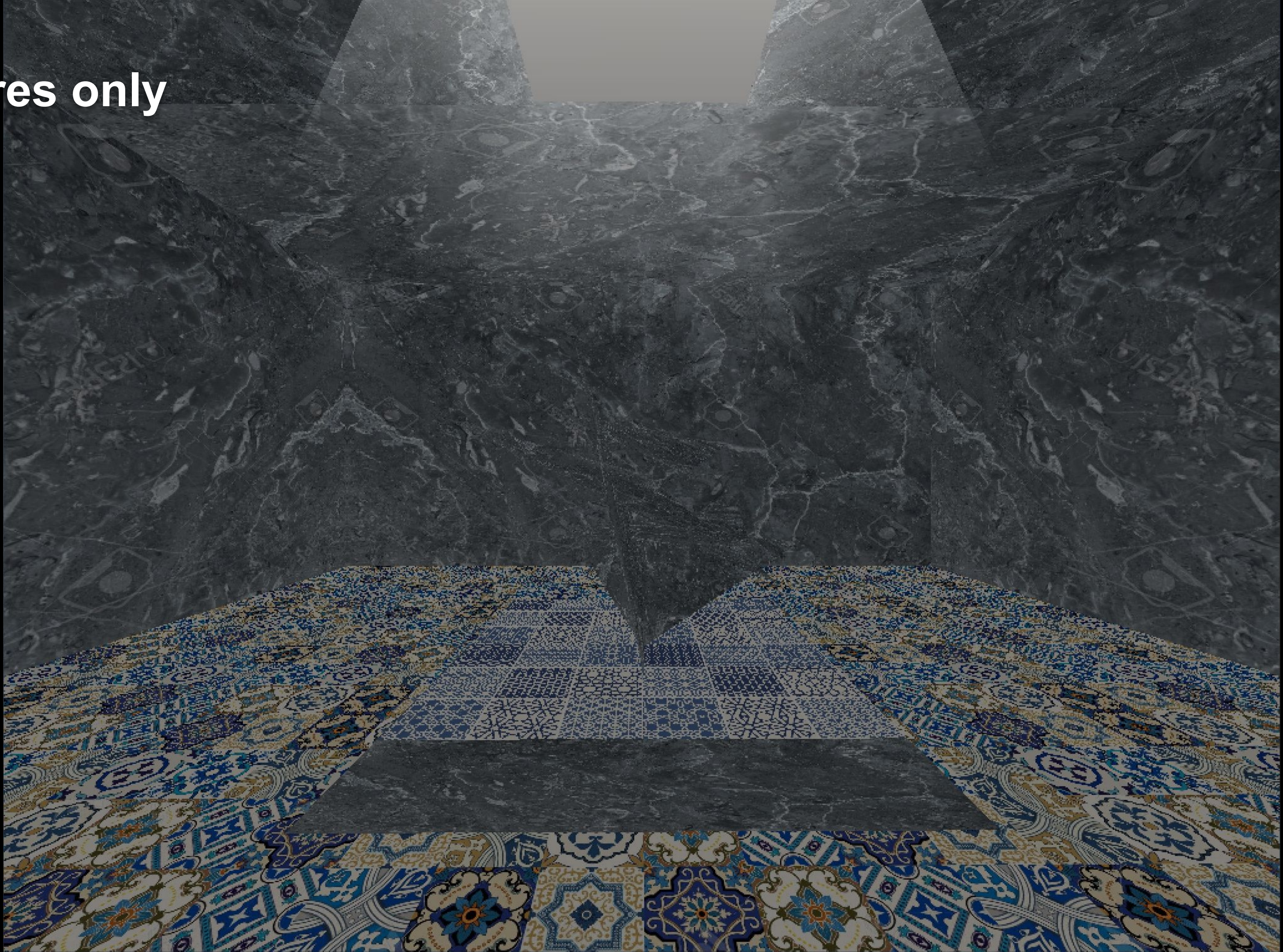


Textures + indirect illumination

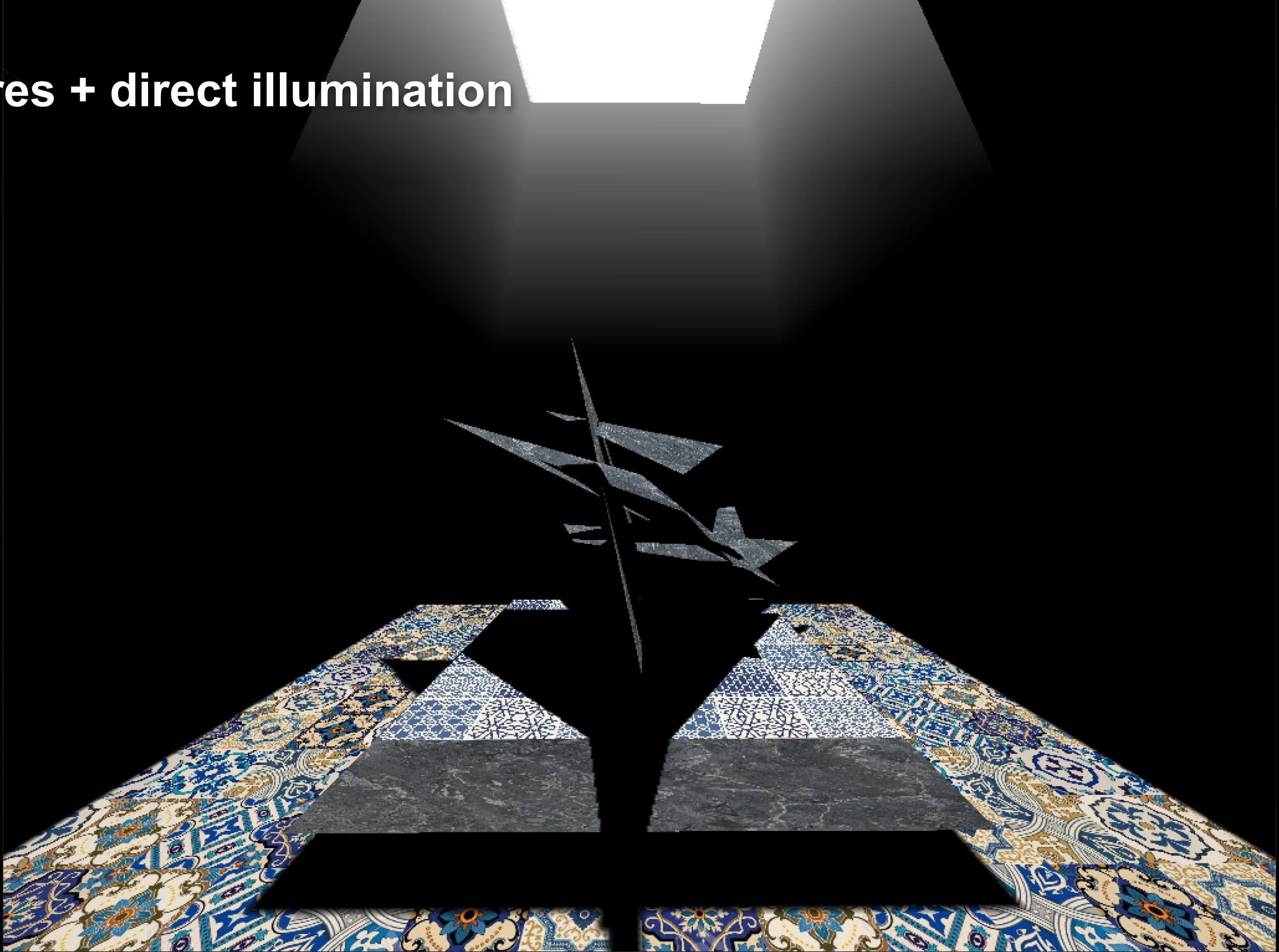


Example 2

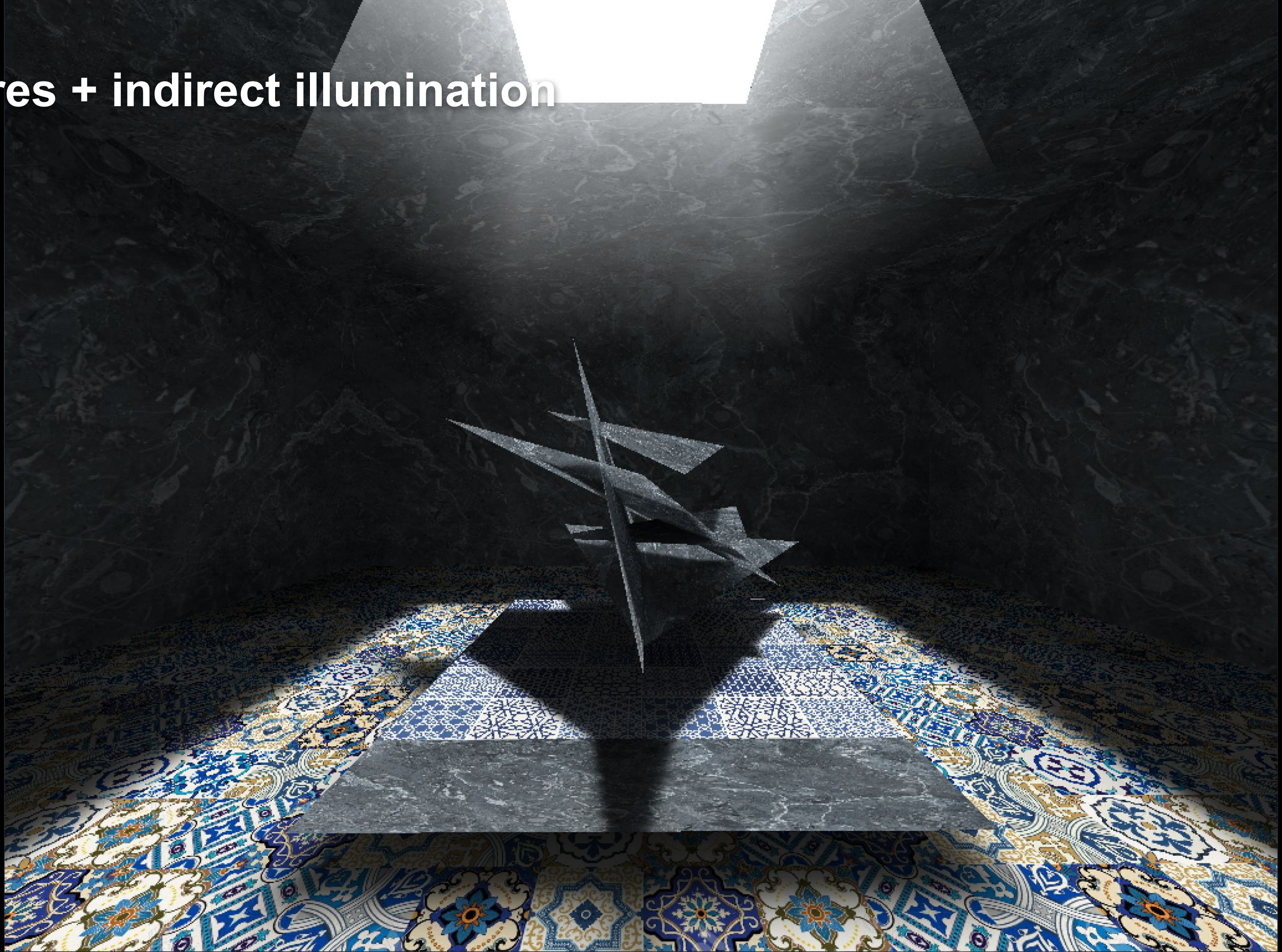
Textures only



Textures + direct illumination



Textures + indirect illumination



Thank you!

Source code available at www.bertolami.com