3D Graphics Programming

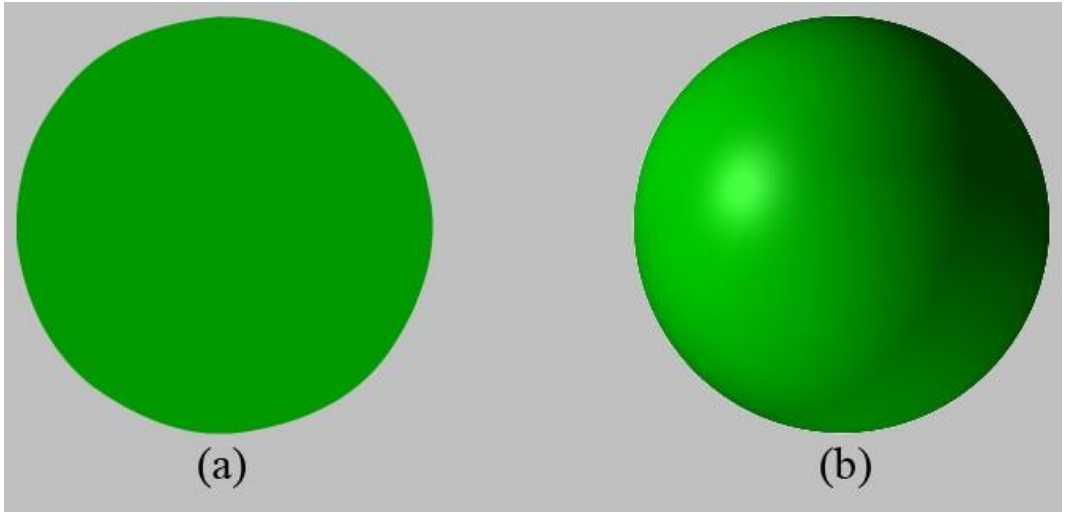
T163 - Game Programming

Week 11

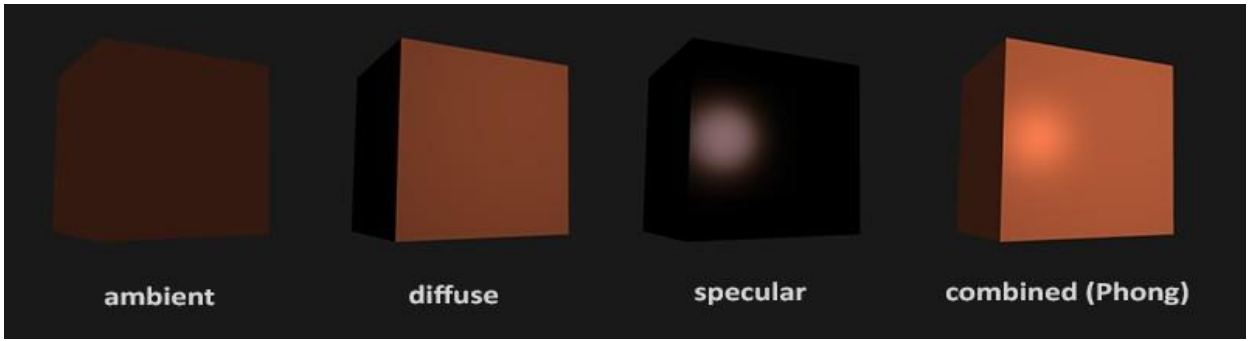
Lighting Intro.

Lighting

- Our visual perception of the world depends on light and its interaction with materials



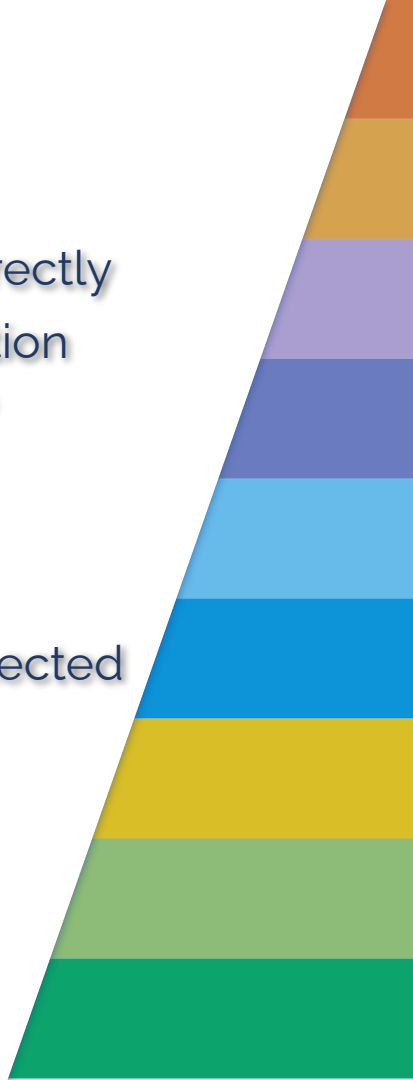
Lighting



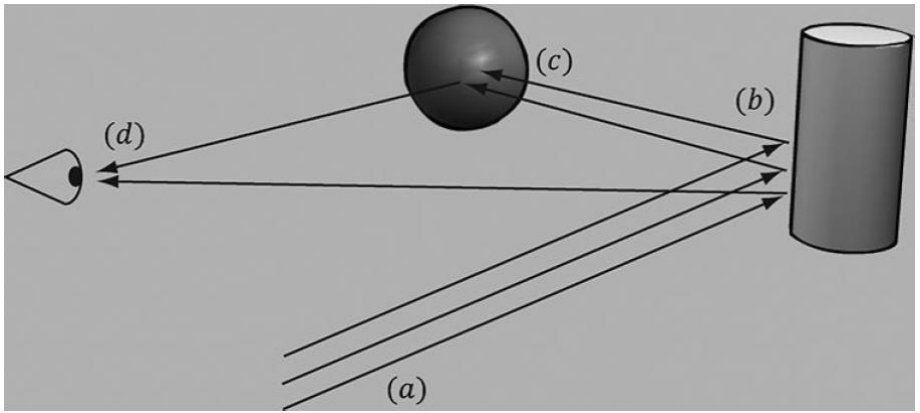
Lighting

- When using lighting, we no longer specify vertex colors directly
- We specify materials and lights then apply a lighting equation
  - Computes the vertex colors for us based on light/material interaction
  - This leads to a much more realistic coloring of the object

- A light source can emit various red, green, and blue light
- Some of that light may be absorbed and some may be reflected



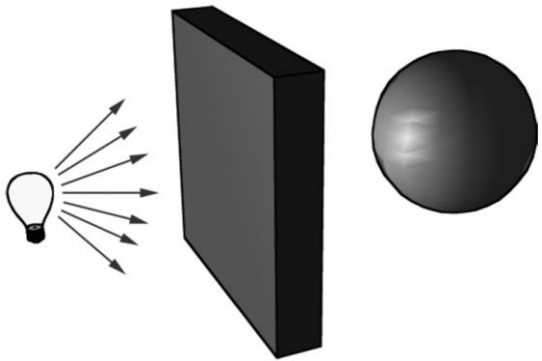
Lighting



- Light (a) strikes the cylinder and some rays are absorbed and other rays are sent toward the eye and sphere
  - The light reflecting off the cylinder toward the sphere is absorbed or reflected again and travels into the eye
  - The eye receives incoming light that determines what the eye sees

Lighting

- The lighting models we are going to look at are **local illumination** models
- Each object is lit independently of another object, and only the light directly emitted from light sources is considered



- It looks like the wall would block the rays emitted by the bulb and the sphere is in the shadow of the wall
- But in local illumination, the sphere is lit as if the wall were not there

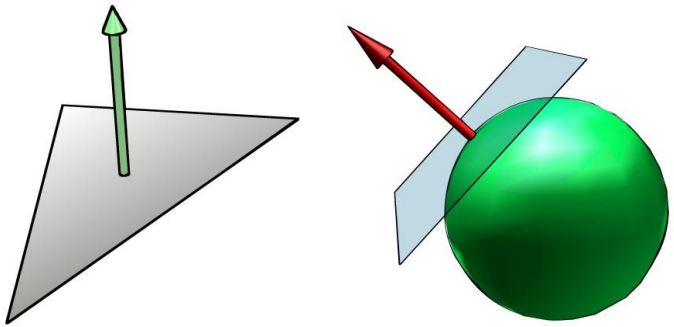
Lighting

- Global illumination models light objects by taking into consideration:
  - The light directly emitted from light sources
  - The indirect light that has bounced off other objects in the scene

- Global illumination models are generally expensive for real-time games
- However, they come very close to generating photorealistic scenes

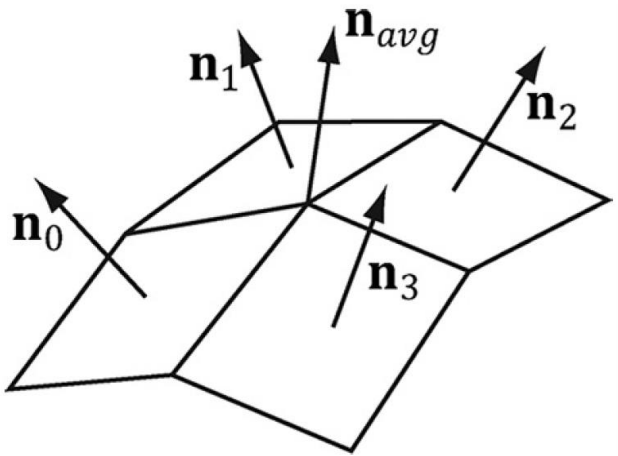
Lighting

- Normal Vectors
  - A face normal is a unit vector that describes the direction a polygon is facing
  - A surface normal is a unit vector that is orthogonal to the tangent plane of a point on a surface



  - (a) The face normal is orthogonal to all points on the face
  - (b) The surface normal is the vector that is orthogonal to the tangent plane of a point on a surface

Lighting



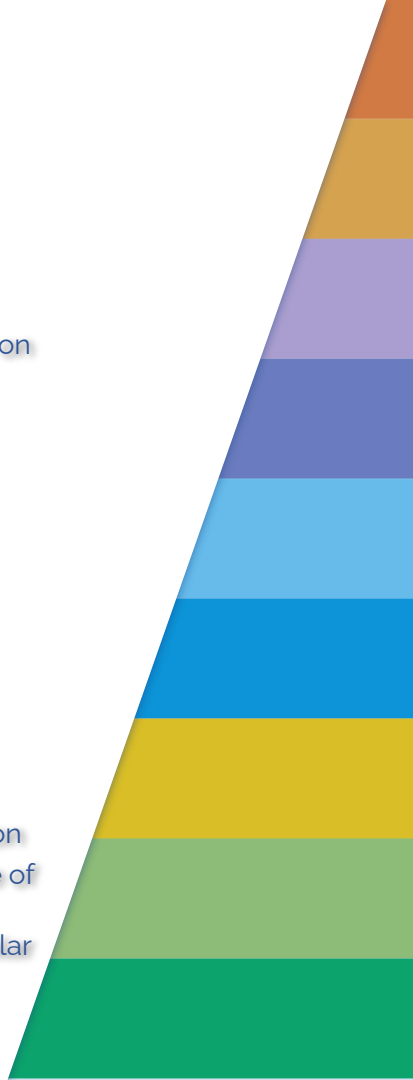
- The technique that is generally applied to triangle meshes is called vertex normal averaging
  - The vertex normal n or an arbitrary vertex v in a mesh is found by averaging the face normals of every polygon in the mesh that shares the vertex v
  - I'll go over the math of how we get a normal now…

Lighting

- Ambient
  - Much light we see in the real world is indirect
  - Some light scatters off the walls or other objects in the room and eventually strikes an object on the side that is not directly lit

- Diffuse
  - Incoming light scatters equally in every direction when striking a diffuse surface
  - The idea is that light enters the interior of the medium and scatters around under the surface
  - Some of the light will be absorbed and the remaining will scatter back out of the surface
  - Because it is difficult to model this subsurface scattering, we assume the re-emitted light scatters out equally in all directions above the surface about the point the light entered

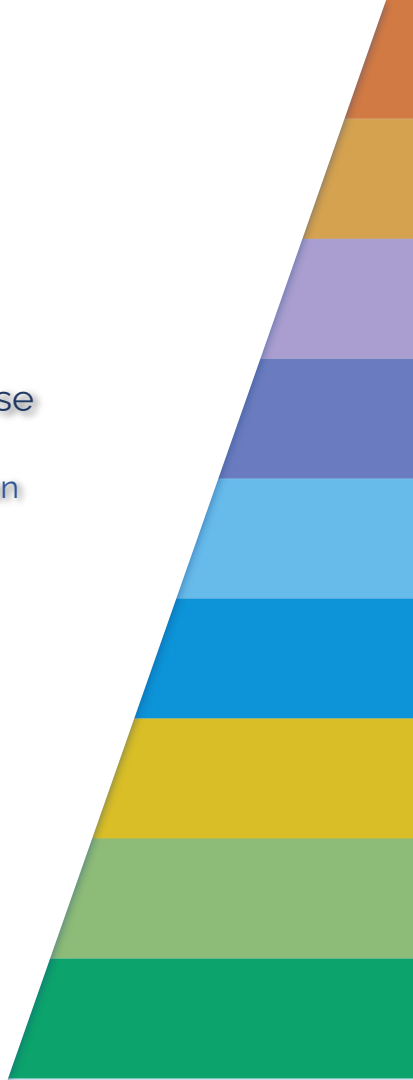
- Specular
  - A second kind of reflection happens due to the Fresnel effect, which is a physical phenomenon
  - When light reaches the interface between two media with different indices of refraction some of the light is reflected and the remaining light is refracted
  - We refer to this light reflection process as specular reflection and the reflected light as specular light



Lighting

- Lecture Example

- The demo for this week will show you how to implement ambient and diffuse lighting on a few different shapes
  - They will be untextured, but if you're brave enough, I can show you an icosahedron
  - The diffuse will be demonstrated as a directional light
- Next week, we'll explore specular light, point lights and spot lights



Week 11

Lab Activities

Week 11 Lab

- For the lab, see Hooman's material (with video)
- OpenGL examples covered:
  - Different lighting models
  - Basic ones (first three examples) then next week, the rest

Week 11

End