Outline: 11/9

- Handout 5 last problem, recap Lab 8
- Introduction to Lighting
- Lab 9: Phases of the moon
- Midterm questions

- **HW 7**: posted tonight, due next Wed
- **Office Hours**: Mon/Tues 4-5pm
  - can also come Thurs 4-5pm
Lab 8: Robotic Arm

```javascript
// set up the cube for the lower arm
lowerCube = new THREE.Mesh(cubeGeom, cubeFaceMaterial);
lowerCube.position.x = 1; // move the lowerCube over
lowerCube.scale.set(2, 0.5, 0.5);

// add it to the lower arm object
lowerArm.add(lowerCube);
lowerArm.position.x = 2; // move the "origin" of the lowerCube over

// set up the cube for the upper arm (exactly the same transformations)
upperCube = new THREE.Mesh(cubeGeom, cubeFaceMaterial);
upperCube.position.x = 1;
upperCube.scale.set(2, 0.5, 0.5);

// add the lowerArm and upperCube to the full arm
arm.add(upperCube);
arm.add(lowerArm);
arm.rotation.set(0.2, -0.4, 0); // just to get a better view
```
Lab 8: Robotic Arm

// Render the scene. This is called for each frame of the animation.
function render() {
    requestAnimationFrame(function() {
        render();
    });

    // update the rotation angle here
    arm.rotation.z += 0.03;
    lowerArm.rotation.z += 0.06;

    renderer.render(scene, camera);
}
Types of Lighting

- Ambient
- Diffuse
- Specular
- Emitted
Ambient

- General Light levels
- Constant
• pixel color = material color * ambient light color
Ambient Light

- Ambient light doesn’t make shapes look 3D!
- So scattered you can’t tell it’s original direction
Diffuse

- Light from a source
- scattered by an object
• pixel color = material color*lightColor*(lightDirection•normal)
• What about non-diffuse (shiny, specular) surfaces?
Specular Light

- Mirror-like
- “shiny”

Mirror surface \((I = R)\)
Specular and Diffuse lighting
Adding up lighting types

Ambient + Diffuse + Specular = Phong Reflection

Credit: Brad Smith
Add it up

• pixel color = ambient + diffuse + specular
Phong Model

• no basis in physics!
• most common model
  • (but there are many others)
Emitted

- Light source is “inside” object
- Looks like it’s glowing
Demo Lab 9
Midterm

- Average: 85
- Median: 88
- $90 \leq g \leq 100$: some type of A
- $80 \leq g < 90$: some type of B
- $65 \leq g < 80$: some type of C
- Below 60: not passing