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## Compilation

Use `make` to create a binary executable in the 'out' directory. The recommended way to run the program is to put the input files in the 'data' directory and use `make run INPUT=input.txt`.

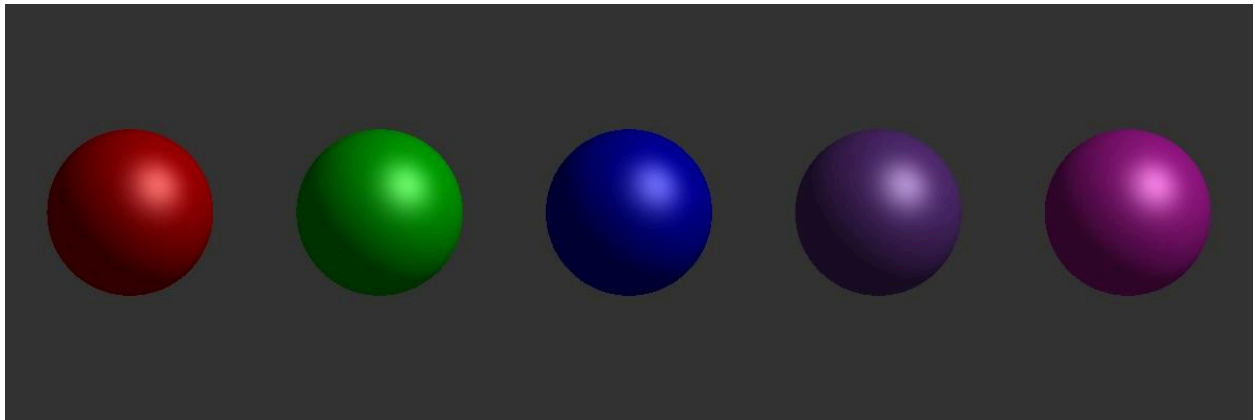
If you have multiple files that are similarly named, you can easily run them all at the same time using `make test`. The files must be in the format `{filename}{num}.{extension}`, like 'example1.txt'. The test files need to be placed in the data folder. You just have to configure the file name, the amount, and the file extension in the config.local.mk file in the config folder. This is the only reason you would need to modify this file.

All images used were generated by my raytracer and their input files can be found in the 'data' directory.

## Effects of Illumination Components

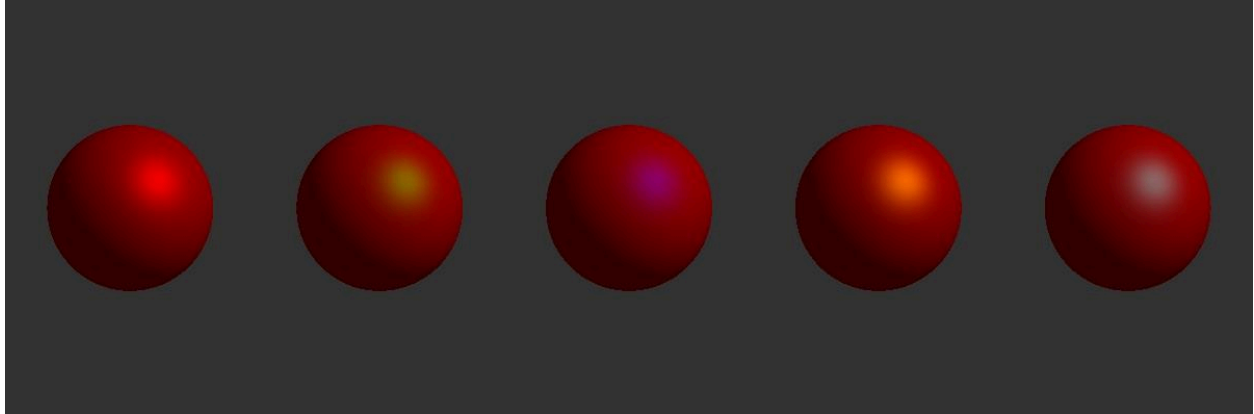
### Effects of $O_{d\lambda}$

This changes the color of the object as a whole.



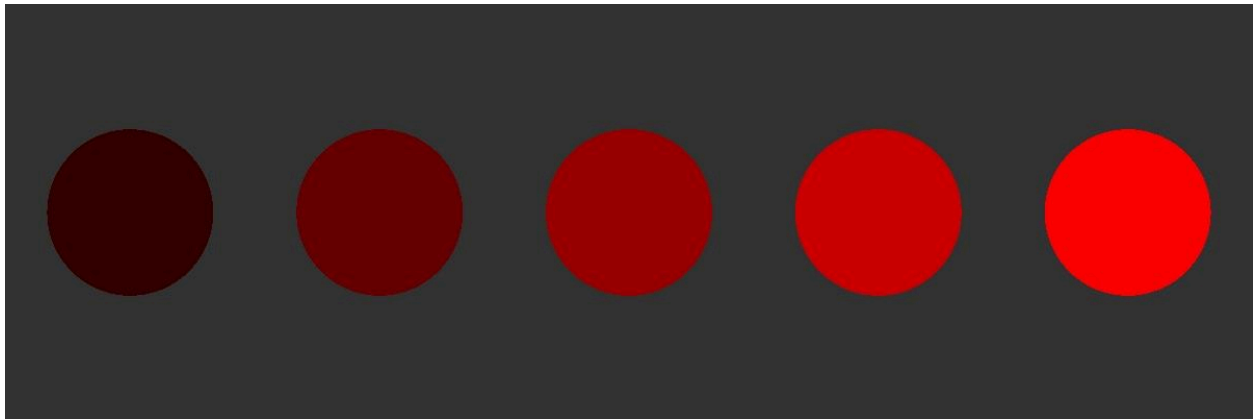
### Effects of $O_{s\lambda}$

This changes the color of the specular highlight.



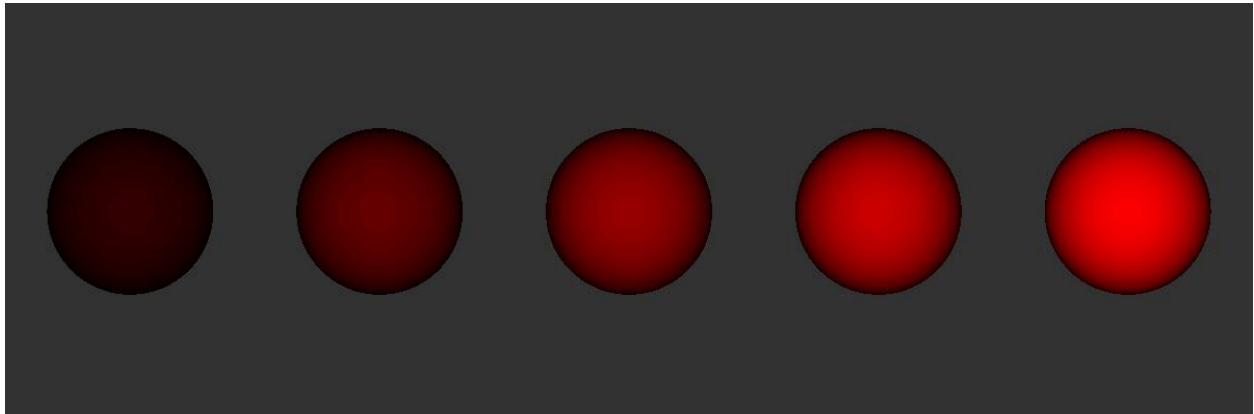
### Effects of $k_a$

This is the ambient term weight and describes how bright the object will be without any light on it. Essentially the brightness at the darkest point.



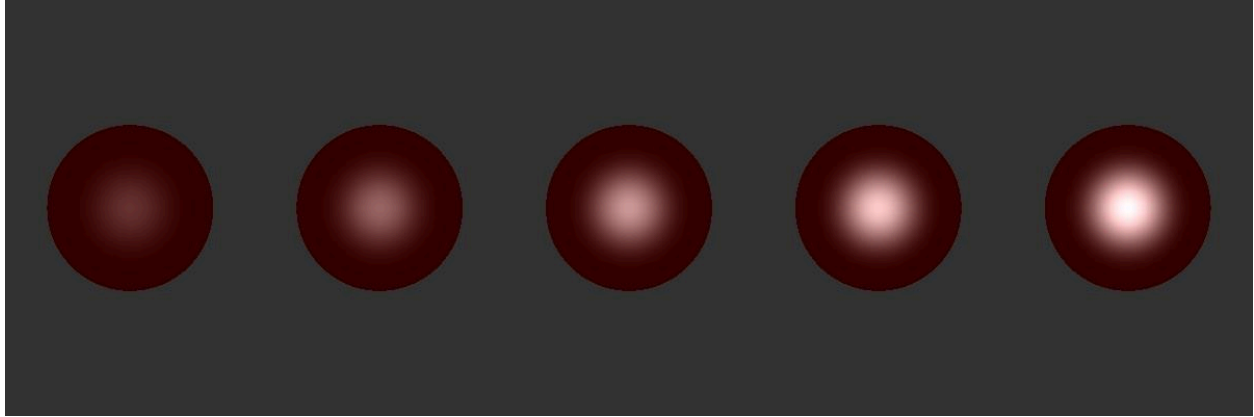
### Effects of $k_d$

This is the diffuse term weight and describes how bright the object will be with light shining directly on it. Essentially how bright the brightest point will be (aside from the specular highlight).



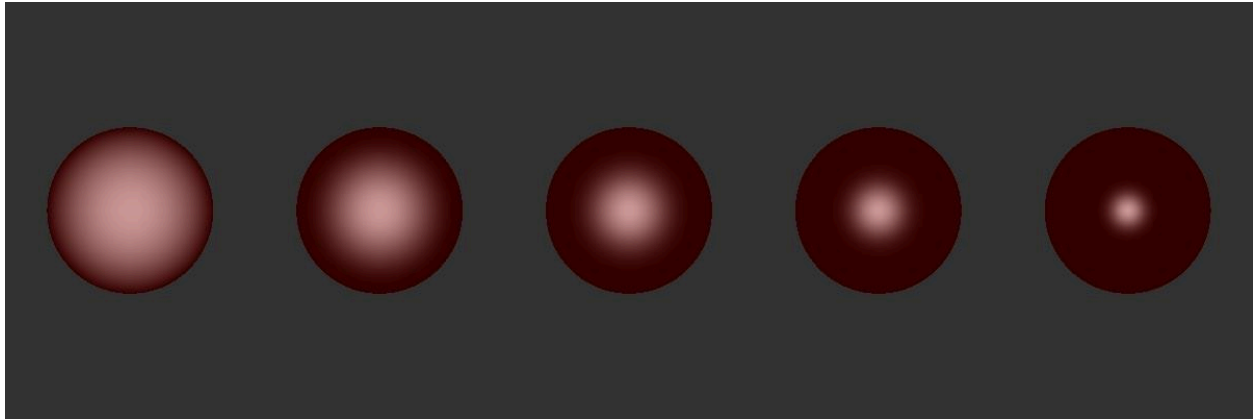
### Effects of $k_s$

This is the specular term weight and describes how bright the object's specular highlight will show. Essentially the maximum brightness of the specular highlight.



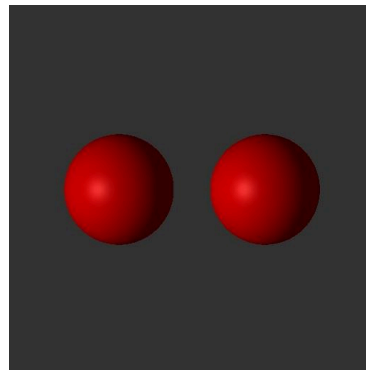
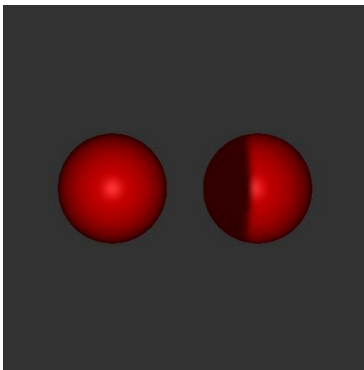
### Effects of $n$

This term controls the focus of the specular highlight. A larger value means the specular highlight will be smaller.



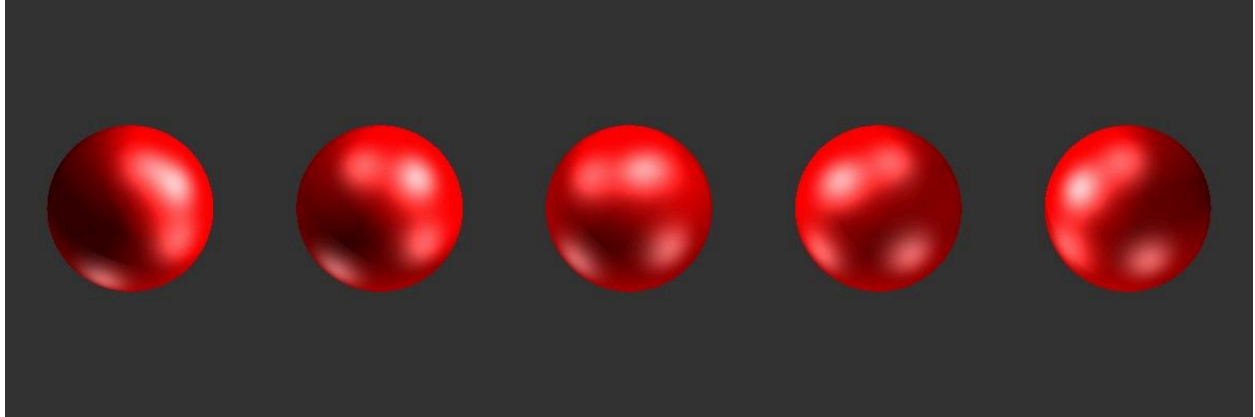
## Directional vs Point Lights

You can get shadows on objects using point lights that you wouldn't be able to get on. That's about the only interesting observation I made with directional and point lighting aside from the obvious. It seems like point lights might be good for mimicking light producing objects while directional lighting might be good for environment lighting and mimicking the sun.



## Multiple Lights vs Single Lights

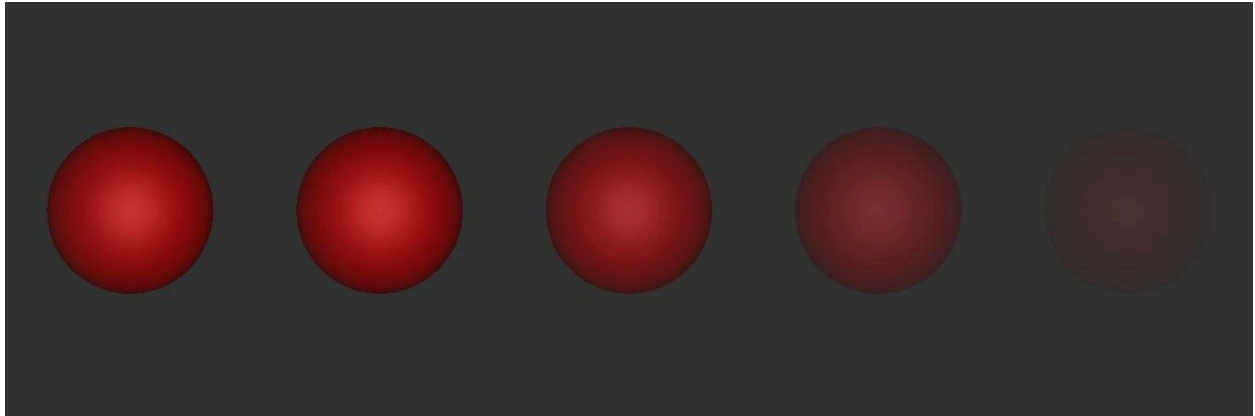
Multiple lights increase the brightness when the intensity is left the same and creates more specular highlights.



## Extra Credit

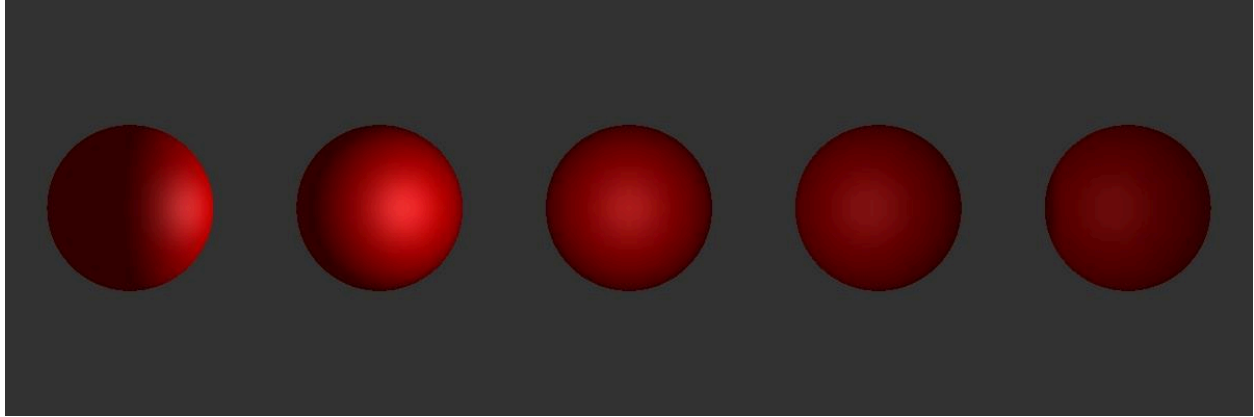
### Depth Cueing

Depth cueing blends the colors after a certain distance from the viewer.



### Light Attenuation

Light mimics the real world and drops off after a certain distance from the light source. The spheres will darken until only the ambient term remains.



### **Soft Shadows**

Soft shadows take an average of the binary value of hitting a sphere between the light source to scale the diffuse and specular terms. It randomly jitters around a certain area when checking for interceptions with spheres. I couldn't quite get this to look great, but it sort of works.

