Project 3A – Ray Tracing 1: Rays, Lights & Spheres
Due: March 12th (11:59pm)

Overview:
In this assignment, you will create a simple ray-tracing application capable of rendering scenes consisting of spheres lit by point light sources. Scenes will be described in a simple, easy to parse text specification file. This is part 1 of a two-part assignment (and counts as half of a normal project). In the second part you will extend this raytracer to incorporate triangle meshes, more complex lighting, and other extensions for more realistic images.

Partner:
Ray tracing has lots of little pitfalls, and I want to make sure people get off on the right track. So, for Project 3A only, you may work with a partner, but you must work alone for Project 3B.

Getting Started:
You already have the `stb_image_write.h` library from Project 2. You can use this to create image outputs. You also have my starter code from Homework 3 which may be a useful reference. You may also wish to use SDL or GLFW to create an interactive UI for displaying and modifying your scenes. All other code you should write from scratch.

A simple scene format has been posted online [*SceneFile.pdf*], this contains information on the camera, all objects, lights and materials in the scene, and output formats. You may need to extend it to implement new features, but be sure you can also support existing files in this format. We have uploaded some scenes consisting of only spheres to get you started [*SphereExamples.zip*]. *NB*: My rendering of these scenes contains some features such as reflection and refraction, which you do not need to implement until Part 2.

Submission Instructions:
Create a sample webpage with:
- Your source code
- Output images
- You must show at least one of the sample scenes along with several new scenes of your own designed to show off each feature of your raytracer. A portion of your grade will come from how well these scenes showcase your system working.
- Brief description of your implementation, any issues you saw, and a list of any extra credit tasks you attempted
- Submission to Art Contest (optional)

Assignment Requirements:
As this is a two-part assignment, Part 1 will be graded out of 50 pts. The number is front is how many points the feature is worth. Partial credit will be given to features that "mostly" work. The required minimum feature set is underlined.

Scene Setup:
(5) Camera placement, film resolution, aspect ratio
(5) User specified background colors
(5) UI + OpenGL output
(5) BMP or PNG output

Primitives:
(5) Spheres
(5) Difference/Intersection of spheres (Constructive Solid Geometry)

Lighting:
(5) Ambient lights
(5) Point light sources
(5) Shadows
(5) Multiple light sources
(5) Directional light sources
(5) Spot light sources

Sampling:
(5) Basic Sampling
(5) Jittered Supersampling
(5) Adaptive Supersampling
(5) Motion Blur
(5) Depth of Field

Materials:
(5) Color & Specularity (Phong Lighting Model)
(5) Refraction
(5) Reflection

Hints:
        -Test your program incrementally
        -Honestly, incremental testing will really help!
        -Get some very small thing working first then move on to more complex
features. First generate a black image of the correct dimensions. Then create a scene
with just a sphere. Have your raytracer return white whenever it hits the sphere.
You should see a white sphere on a black background. Now make sure you feel
confident in your ray/sphere intersection code. Move the sphere around, make sure
the right things happen. When this works, mess around with the image aspect ratio
(make it very narrow), make sure everything works as expected. Then try to get
material colors working. Then add support for point lights, then phong shading.
Only move on to a new feature when you're sure everything else works so far.
        -If you don't do this, you'll end up with a big pile of broken code and neither I
nor the TAs will be able to help you.
        -Please, please test as you go along!

Extra Credit *(Optional, up to 10 point)*:

The assignment is graded out of 50 points. The required material is only 35 points, and you must complete an additional 15 points of work to receive full credit. If you have 50 points worth of working features, you may turn in up to 10 points worth of additional features to be graded as extra credit. *You must explicitly identify which features you are submitting as extra credit* as these will be graded with extra scrutiny. As with all other features, be sure to document your extra credit working through text and illustrative images in your report.

Art Contest *(Optional, variable points)*:

Finally, there will be a small art contest where you can submit your favorite sphere rendering. You may submit up to two images to the art content, and your submitted images must consist only of spheres, or the union, intersection, of difference of spheres rendered by your raytracer. Any artistically interesting picture will receive 1 additional point of extra credit. An overall class winner (decided by the teaching staff) will receive 5 points.