

Algorithm 6: Ray

October 22, 2021

Introduction to Computer Graphics, Fall 2021

Due Date: 12:00 PM EST on **October 22** (before algo solutions are released).

Instructions: You may discuss this assignment with other students, but you must abide by the rules stated in the collaboration policy (no notes from any discussions, your handin must be completely written up by you and contain only your own work, 15 minute delay between discussions and writing down any notes of your own) and write the logins of the student(s) you collaborated with next to each problem. Hand in the assignment on Gradescope as a PDF (please make sure the document is anonymous) no later than 12:00pm EST on the due date. *Late hand-ins are not accepted under any circumstances.*

1. The high-level view of our ray tracer is exactly the same as for intersect, except for a few additions. Below is the high-level pseudocode for intersect.

[1 point] **1.1:** What needs to be changed / added to make this a full implementation of the Phong lighting model?

[1 point] **1.2:** What needs to be changed / added to make this a full-fledged raytracer?

(Note: Just specify what changes need to be made – no pseudocode please.)

2. [2 points] Given vector \vec{v} from the surface to a light and the surface normal \vec{n} , find the equation for the vector \vec{r} which is the reflection of

Algorithm 1 RAY-TRACE($Scene, Canvas$)

for $point \in Canvas$ **do**

 cast a ray to find the nearest object

if ray intersects an object **then**

for each light **do**

 cast a ray to the light and evaluate the lighting equation

$Canvas[pt] = Canvas[pt] + \text{ambient color} + \text{diffuse color}.$

end for

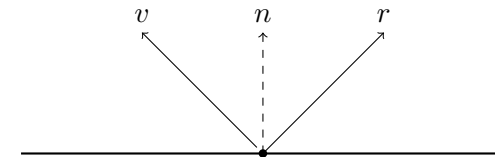
else

$Canvas[pt] = \text{background color}$

end if

end for

an **incoming** light ray about \vec{n} . Write your equation in terms of vector operations. How do you compute the color contributed by the reflected ray? Give a brief description.



3. [1 point] In words, how does attenuation affect the light shown in a pixel?
4. [1 point] When would an object (or portions of an object) not be affected by a light source? Provide at least 2 examples. You can list more for extra credit.

5. [**2 points**] Recall that we can think of texture mapping in two steps. First, mapping from the object to the unit square, and second, mapping from the unit square to the texture map. Let u and v be the x and y values in the unit square that a particular point on an object gets mapped to in the first step. Note that u and v are calculated differently depending on the object. From here, how do you find the coordinates (s, t) to look up in a texture map in terms of u, v, j, k, w and h , where j and k are the number of repetitions in the x and y directions, respectively, w is the texture width, and h is the texture height? (You may assume that both the u, v and s, t coordinate systems are oriented with $(0,0)$ in the same corner.)
6. [**1 point**] Given the ambient, diffuse, and specular components of a surface point's color, what's the equation for the pixel's color, adding in the color of the surface's texture map at that point? (**Hint:** You'll also need the color of the texture map and the *blend* value in the lighting equation but you shouldn't need any other parameters)
7. [**1 point**] What is the purpose of the specular exponent in the Phong lighting model?
8. [**Extra credit**] Compare and contrast path tracing and ray tracing: what are the advantages and disadvantages to each? What are alternative global illumination methods? (Note that ray tracing does not cover global illumination.)