Algorithm 5: Ray

Comp175: Introduction to Computer Graphics – Spring 2016

Algorithm due: **Monday April 11th** at 11:59pm

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1 Instructions

Complete this assignment only with your teammate. When a numerical answer is required, provide a reduced fraction (i.e. 1/3) or at least three decimal places (i.e. 0.333). Show all work; write your answers on this sheet. This algorithm handout is worth 3% of your final grade for the class.

[2 points] 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`. What needs to be changed/added to make this a full-fledged ray-tracer? Just specify what changes need to be made no pseudocode please.

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
      $Canvas[pt] = Canvas[pt] + color$ with only diffuse/ambient components
    end for
  else
    $Canvas[pt]$ = background color
  end if
end for

When casting a ray from the intersection to each light during illumination, check if the first object that the ray intersects with is the light source. If it is, count the light's full contribution. If not, don't count the light's contribution. This casts shadows.

Spawn new reflection ray at intersection point. Do this recursively until light contribution is negligible or the max recursive depth has been reached. Skip reflection rays if the material properties of the object is not reflective.

[2 points] Given a vector $\vec{v}$ and a surface normal $\vec{n}$, find the equation for the vector $\vec{r}$ which is the reflection of $\vec{v}$ about $\vec{n}$ (i.e. in the equal and opposite direction). Write your equation in terms of vector operations. How do you compute the color contributed by the reflected ray? Give a brief description.

$\theta = cos^{-1}(\vec{v} \cdot \vec{n})$
$ray = sin(\theta) * \vec{v} + \vec{n}$

We calculate the angle between the normal and the vector by using the inverse cosine of the dot product. This angle is the same as the angle between the normal and the reflected ray. We use this to calculate the ray.

[1 point] Is ray tracing a local or global illumination algorithm? Why?

Global; it takes into account the interaction of light from all the surfaces in the scene.

[1 point] For a particular ray that intersects with an object, when do you not consider

contribution from a given light source? How do you computationally determine when this scenario occurs?

When an another object is blocking the light source. Cast a ray from the object to the light. If the first object the ray intersects with is not the light, then don't count that light's contribution.

[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 a and b 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, i, j, w and h, where i and j are the number of repetitions in the x and y directions, respectively, w is the texture width, and h is the texture height?

$s = uw$
$t = vh$

[1 point] How do you use the color from the texture map and the `blend` value in the lighting equation?

We add the pixel color from the texture map multiplied by the blend value with the object's pixel color multiplied by 1 minus the blend value. e.g. $R = R_t * blend + R_o * (1 - blend)$

[1 point] What is the Phong lighting model used for? What is the purpose of its exponent? It's used to calculate the specular light. The exponent, f, is the surface property for specular highlight.

2 How to Submit

Hand in a PDF version of your solutions using the following command:

```
provide comp175 a5-alg
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