

## Algo 4: Lighting

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Introduction to Computer Graphics, Fall 2022

Due:

### 1) Light ray calculation

- a) Lighting components. In the following ingredients, select out which ones are used for which part.
  - (1) Surface normals and positions
  - (2) Surface materials
  - (3) Light sources
  - (4) Camera rays
- I) Phong model
- II) Reflection
- III) Texture mapping
- b) In the following pseudo code, what needs to be changed / added to make this a full-fledged raytracer?

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#### Algorithm 1 RAY-TRACE(*Scene*, *Canvas*)

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```
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
```

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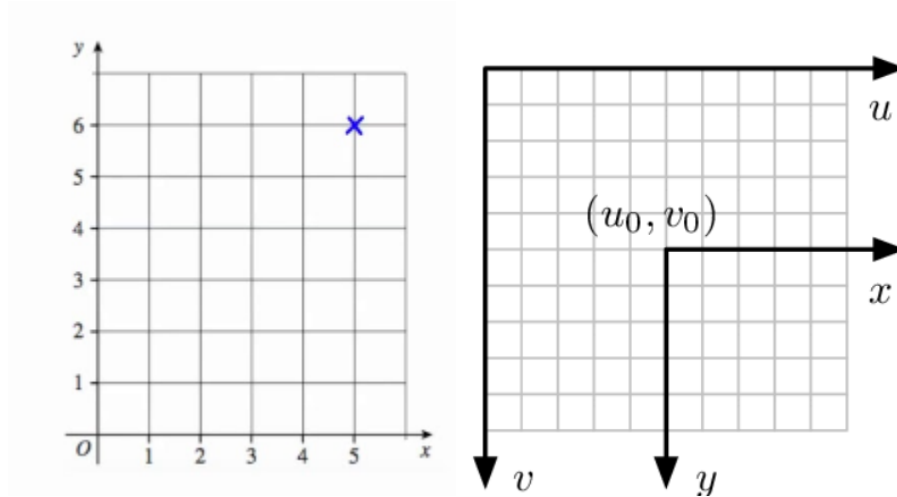
### 2) Reflection equation

Calculating the reflected direction of light on surface is an important part of implementing lighting. Given the light direction  $L$ , normal  $N$ , write down the function for getting reflection direction.

### 3) Texture coordinates

In most cases, your shape's texture coordinates may have different coordinates than the texture images. In the case below, surface texture coordinates originates from left bottom while the image from left top. Suppose you want the image to show on the surface(as the way they look here).

- a) Suppose image and surface both has a size of  $(w, h)$ . What's the location of a pixel  $(u, v)$  on the surface?
- b) From question 1. Suppose that you want to repeat the texture  $n$  times. What's the location of pixel  $(u, v)$  on the surface now? (Multiple positions, express in a way you feelbest!)



#### 4) Shadow generation

In the normal process of adding shadows, you need to do the intersection again in the scene from the previous intersection point. Here is the problem, do you have to detect intersections with the previous intersected object itself? Why?