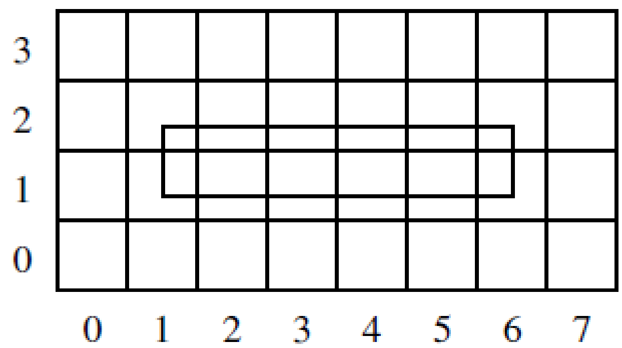
CS 447/547: Computer Graphics

Homework 4

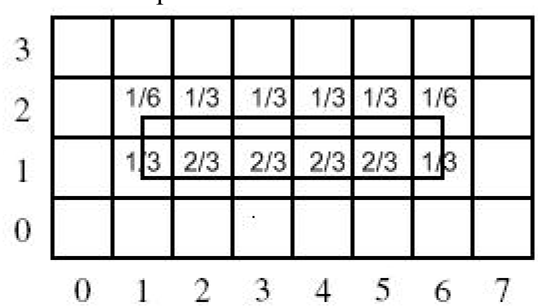
This homework must be done individually. Submission date is November 25, 2013, in class.

Question 1: Consider a one pixel wide line from (1, 1.33) to (6, 1.33), with square endcaps. The outline of the line is shown on the figure below. Integer locations are at the center of each pixel.

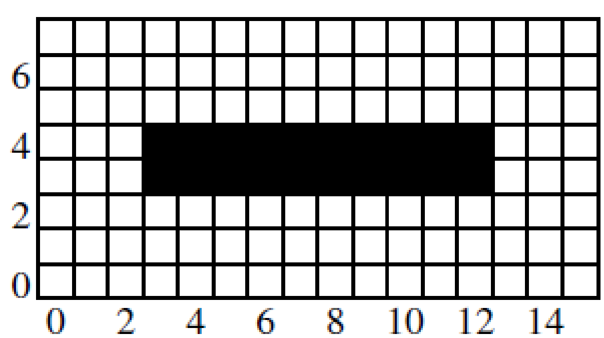
a. Assume we are doing area-weighted sampling, with the alpha of each pixel set in proportion to the amount of the pixel covered by the line. Give the alpha values of all the pixels. (Hint: the value for (1,1) is 1/3). (8 points)



Answer: Only non-zero values are provided.



b. Now assume we are doing super-sampling. Below is the same line, drawn at twice the resolution using some version of point sampling which fills whole pixels.

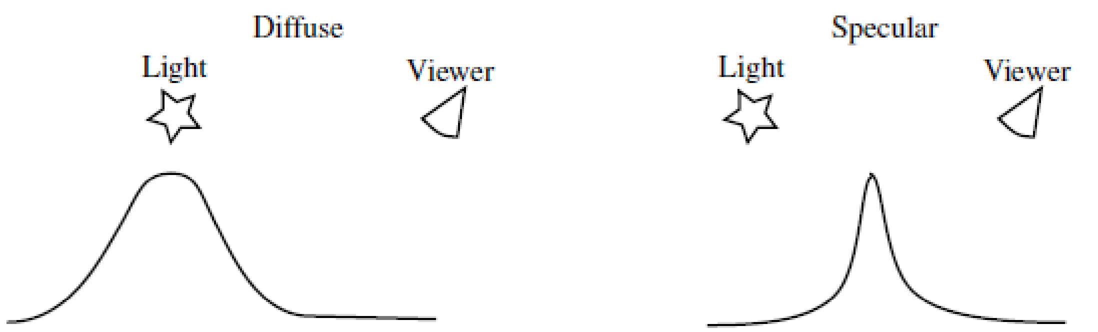


Halve the size of this image by averaging 2× 2 blocks of pixels. Please fill the numbers in the grids below. Assume the intensity for black is 0 and white is 1. (Hint: the value for (0, 0) is 1, and (2, 2) is 0.5). (8 points)

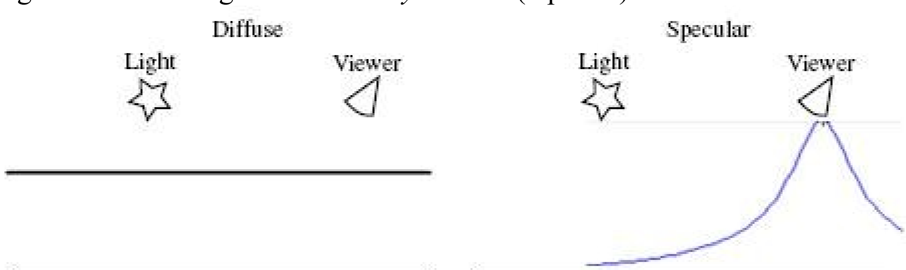
Answer: Only non-one values are provided.

3								
2		3/4	1/2	1/2	1/2	1/2	3/4	
1		3/4	1/2	1/2	1/2	1/2	3/4	
0								
	0	1	2	3	4	5	6	7

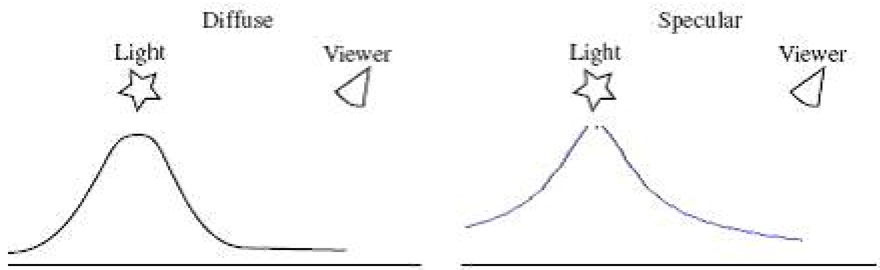
Question 2: Below are shown the illumination graphs for the diffuse and specular components of a flat surface lit by a light as shown with a viewer in the position indicated.



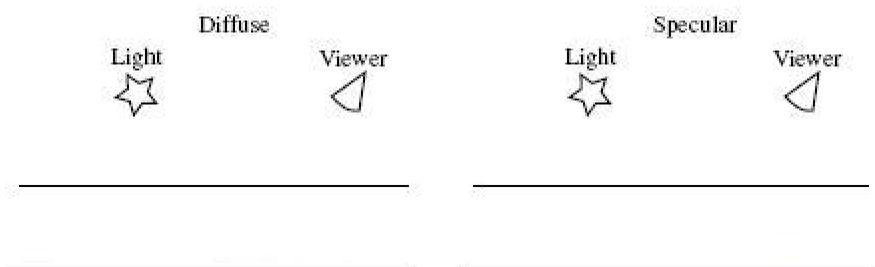
a. Draw two more graphs, one for the diffuse and one for the specular component of the same flat surface. However, now make the *distant light assumption*, using a directional light source coming from *vertically above.* (6 points)



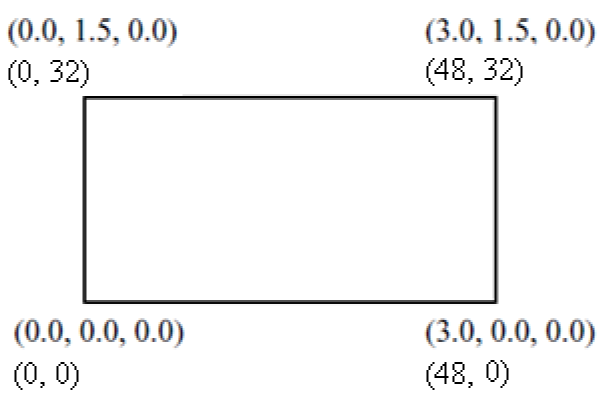
b. Draw two more graphs, but now make the *distant viewer assumption*, assuming that the viewer is looking from a constant direction *vertically down* to the surface. Use the point light from the original example, NOT a directional light. (6 points)

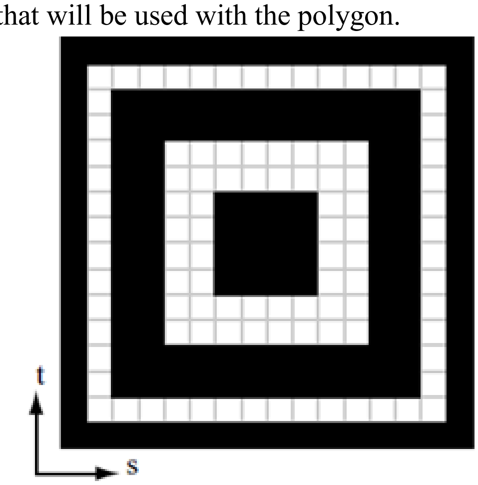


c. Draw two more graphs, showing the effect of **both** a directional light coming from above and a distant viewer looking from above. (6 points)



Question 3: On the left is a polygon with both its world coordinates and texture coordinates marked. For example, the world coordinate for the bottom-left is (0, 0, 0) and its texture coordinate is (0, 0). On the right is a 16x16 texture map that will be used with the polygon.





a. Draw the mipmap level L1, L2 and L3 for the texture. Indicate the intensity of each pixel in each mipmap, and assume the mipmaps are generated by averaging pixels. Assume the intensity for *black* is 0 and the intensity for *white* is 1. (12 points)

1/4	1/2	1/2	1/2	1/2	1/2	1/2	1/4
1/2	0	0	0	0	0	0	1/2
1/2	0	1	1	1	1	0	1/2
1/2	0	1	0	0	1	0	1/2
1/2	0	1	0	0	1	0	1/2
1/2	0	1	1	1	1	0	1/2
1/2	0	0	0	0	0	0	1/2
1/4	1/2	1/2	1/2	1/2	1/2	1/2	1/4

L1

5/16	1/4	1/4	5/16
1/4	3/4	3/4	1/4
1/4	3/4	3/4	1/4
5/16	1/4	1/4	5/16

L2

25/64	25/64
25/64	25/64

L3

25/64

L4

b. The polygon is rendered with a perspective view looking toward the negative z axis with the positive y axis pointing up. The viewing and window parameters are such that, for the polygon, each unit of distance in world space appears as 3 pixel lengths on the screen. Which mipmap should be used for texturing the polygon? Show your working, and assume nearest mipmap nearest as the texture interpolation mode. (8 points)
(Hint: you need to calculate the λ values for both *x* and *y* direction. You can calculate the λ value for *x* as follows: $\lambda_x = \log_2 \frac{texels\ in\ x\ direction}{pixels\ in\ x\ direction} = \log_2 \frac{48}{3\times 3} = 2.4$)

Answer:

$$\lambda x = \log_2\left(\frac{16 \times 3}{3 \times 3}\right) = 2.4$$

$$\lambda y = \log_2\left(\frac{16 \times 2}{3 \times 1.5}\right) = 2.8$$

, so L3 mipmap should be used.