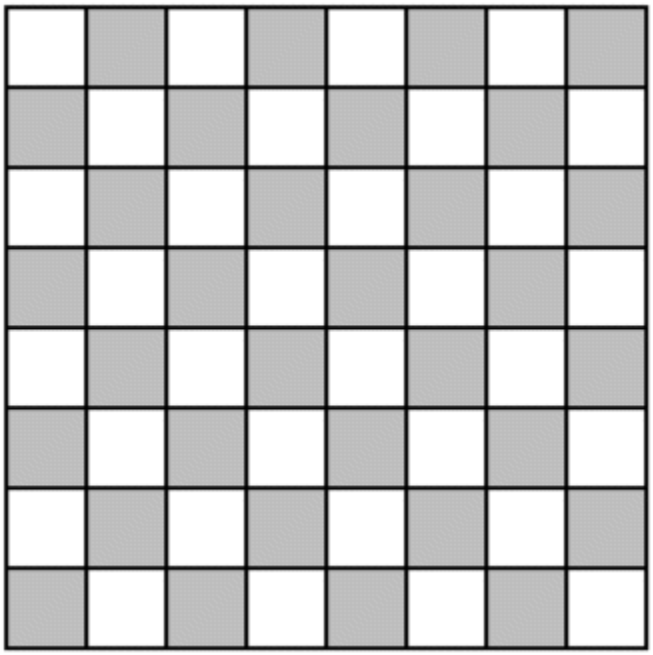
CS 418: Interactive Computer Graphics Spring 2019
In-class Worksheet: Texture Coordinates and Filtering

Texture Filtering

1. **Magnification**
   Suppose we have the following 8x8 texture of greyscale values



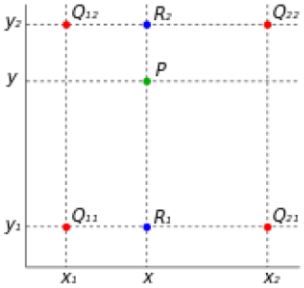
- Texel (0,0) is located in the lower left hand corner.
- White texels have RGB values of (1,1,1)
- Grey texels have RGB values of (0.5, 0.5, 0.5)

Suppose a fragment has (u,v) texture coordinates of (3/4, 19/32).

a. What fragment color is generated using nearest neighbor?
Recall that in nearest neighbor filtering you sample the texel (s,t):
$s=\text{round}(u\times width-1/2)$ $t=\text{round}(v\times height-1/2)$

s=round(3/4 x 8 -1/2) = round(5 1/2) = 6
t=round(19/32 x 8 -1/2) = round(19/4 – 1/2)= round(17/4) = 4
T(6,4)=(0.5,0.5,0.5)

b. What fragment color is generated using bilinear filtering? Recall that bilinear filtering takes the following form:



$$f(x, y_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$
$$f(x, y_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$

$$'(x, y) \approx \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2)$$

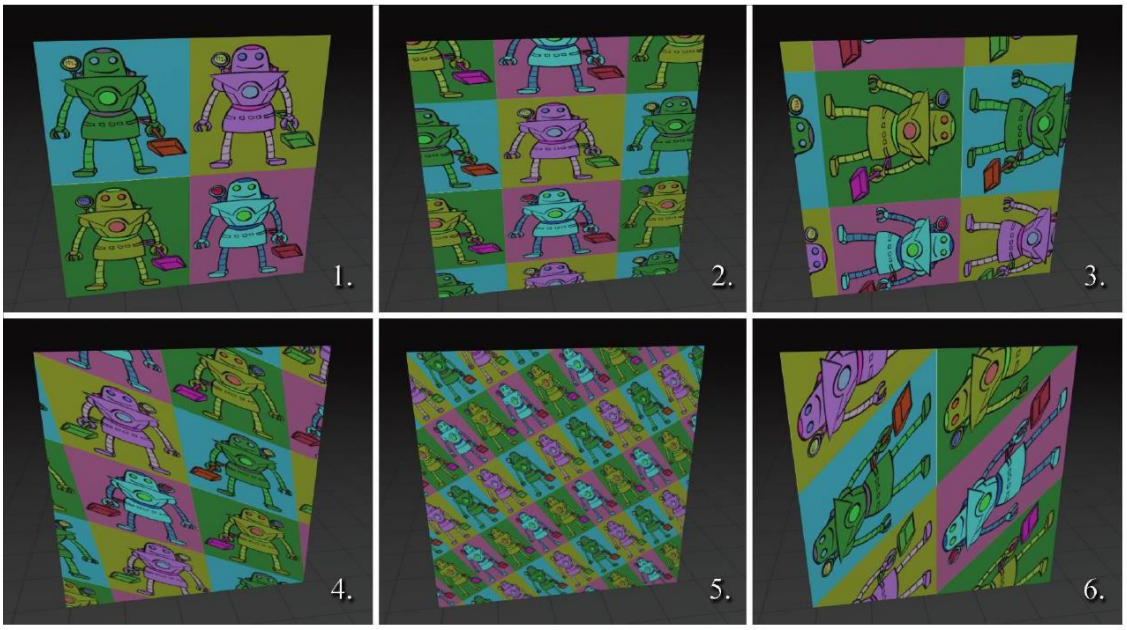
To generate the (s,t) coordinates in this case, you would do:
s= 3/4 x 8 = 6
t=19/32 x 8 = 4 ¾
…but for the purposes of illustrating how to perform bilinear interpolation, lets compute the value for T(5 ½, 4 ¼) instead

T(5 ½ , 4) = ½ T(5,4) + ½ T(6,4) = ½(1,1,1) + ½ (0.5,0.5,0.5)
= (0.75,0.75,0.75)

T(5 ½ , 5) = ½ T(5,5) + ½ T(6,5) = ½(0.5,0.5,0.5) + ½ (1,1,1)
= (0.75,0.75,0.75)

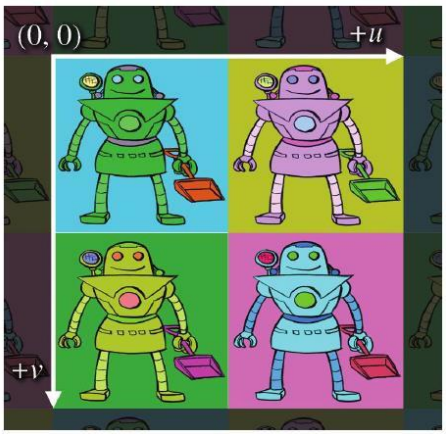
T(5 ½, 4 ¼)= ¾ T(5 ½ ,4) + ¼ T(5 ½,5)
= ¾(0.75,0.75,0.75)+1/4(0.75,0.75,0.75) = (0.75,0.75,0.75)

2. Texture Coordinates



Match each textured quad above with the set of texture coordinates used to generate it given in the list below. The upper left vertex is number 0 and the vertices are enumerated clockwise around the quad.

(a)	$0:(0.20,-0.30)$	$1:(1.30,-0.30)$	$2:(1.30,1.20)$	$3:(0.20,1.20)$
(b)	$0:(5.00,-1.00)$	$1:(6.00,-1.00)$	$2:(6.00,0.00)$	$3:(5.00,0.00)$
(c)	$0:(1.00,0.00)$	$1:(-0.23,-0.77)$	$2:(0.00,1.00)$	$3:(1.24,1.77)$
(d)	$0:(2.00,0.00)$	$1:(1.00,1.00)$	$2:(0.00,1.00)$	$3:(1.00,0.00)$
(e)	$0:(-0.10,1.10)$	$1:(-0.10,0.10)$	$2:(0.90,0.10)$	$3:(0.90,1.10)$
(f)	$0:(0.00,-1.00)$	$1:(3.35,0.06)$	$2:(1.00,2.00)$	$3:(-2.36,0.94)$



a=2, b = 1, c=4, d=6, e = 3, f = 5