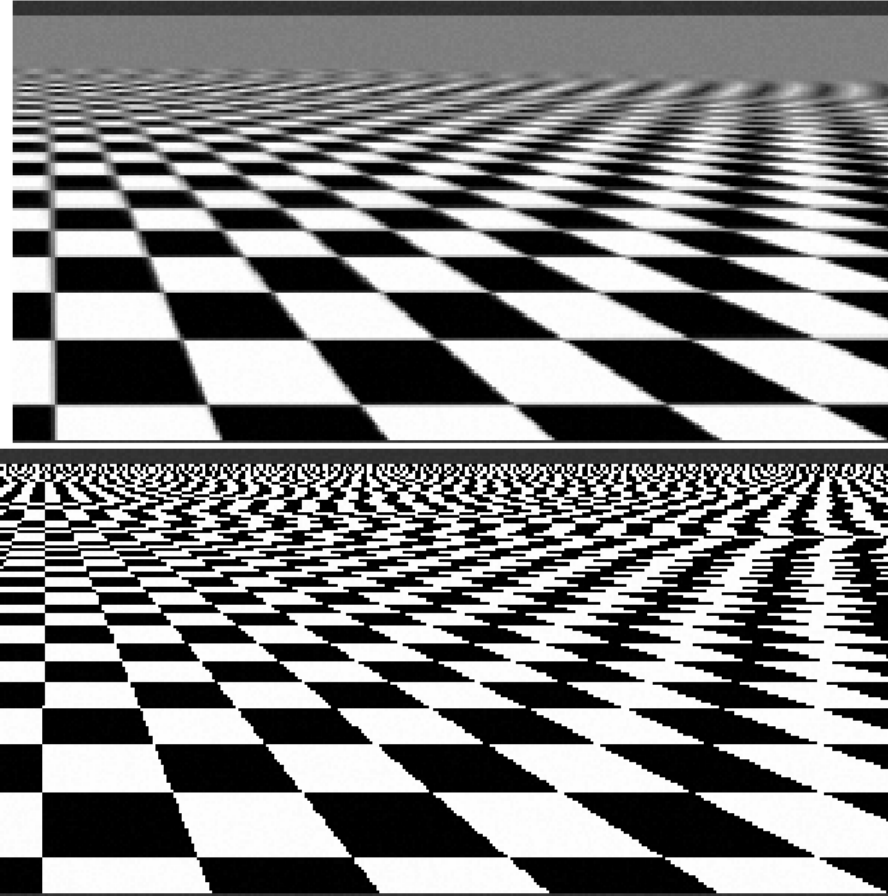


Name:

CMPS 160  
Intro to Graphics  
Spring 2005

Final Exam

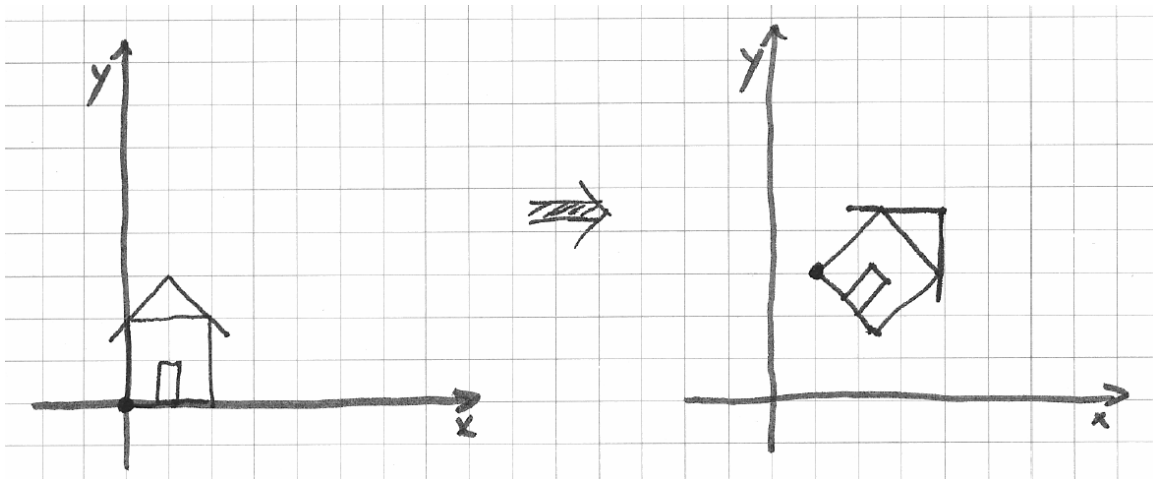


1a. Suppose we use OpenGL to render a checkerboard texture on a single polygon, without texture filtering during texture lookup, and using a single sample per pixel during rasterization (no supersampling). Which image would we expect to see and why?

1b. Now suppose there was texture filtering, but still with a single sample per pixel during rasterization. Which image would you expect to see and why?

1c. Now suppose that instead of texture we use lots of small square polygons that are colored black and white. What would the image look like? Why?

2. What is the matrix necessary to perform the following 2D transformation? (You don't need to actually solve the math, just set up far enough that I would get an actual matrix result if the math was completed.)



3. Suppose we have a line extending from  $(0,0,0)$  to  $(1,0,0)$ . We apply a single rotation to move one endpoint of the line to  $(0,0,1)$ . Which vector was used as the axis of rotation?

4. Suppose we set up a camera using `gluLookAt(eye=[1,5,0], center=[2,5,0], up=[0,1,0])`, and then render a scene with three spheres of radius 1, centered at `[4,6,4]`, `[5,8,-2]`, and `[7,-1,1]`.

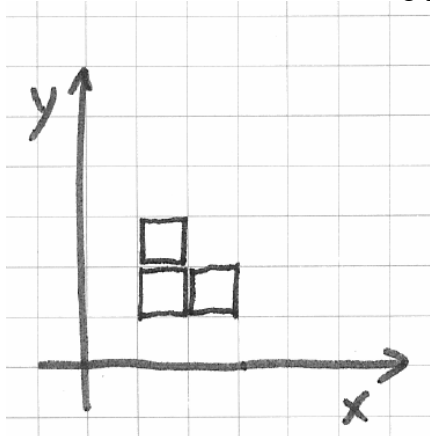
a. Can we use a near plane with distance zero and a far plane of “really far”? Why or why not?

b. What are the best distances for the near and far planes?

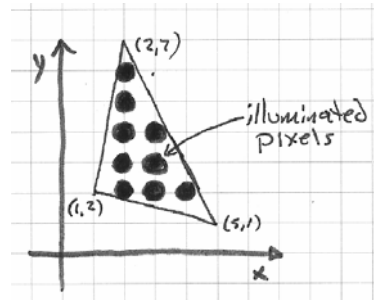
5. Suppose we have a minimal graphics language called SimpleGL which does not support a full range of commands. It has only the following:

<code>SGL_TranslateX()</code>	<code>= glTranslate(1,0)</code>
<code>SGL_TranslateY()</code>	<code>= glTranslate(0,1)</code>
<code>SGL_PushMatrix()</code>	<code>= glPushMatrix()</code>
<code>SGL_PopMatrix()</code>	<code>= glPopMatrix()</code>
<code>SGL_DrawBox()</code>	<code>= {glBegin();glVertex(0,0);glVertex(0,1);glVertex(1,1);glVertex(1,0);glEnd()}</code>

How can we draw the following picture using the fewest commands?

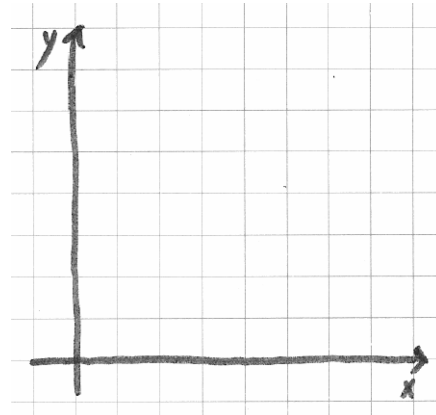


6. Suppose we have a graphics system that rasterizes polygons by turning on pixels that are strictly inside the bounds of the polygon. For example:



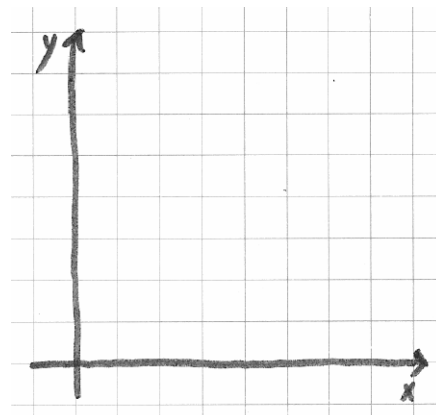
a. Suppose we execute the following, which pixels will be turned on?

```
glBegin()
glVertex(0,0)
glVertex(6,0)
glVertex(6,6)
glVertex(0,6)
glEnd()
```



b. Suppose that this system can not rasterize quadrilaterals directly, and instead breaks them into triangles. What are the vertices of two triangles that would represent this quad?

c. Suppose we now rasterize these two triangles, which pixels will be turned on?



d. What is wrong with this rasterizer and how might we fix it?

7. We want to obtain a foreground matte of a small statue to composite into a computer graphics rendering. One way to capture this matte is to photograph the statue in front of a blue screen. For simplicity suppose that the blue screen is ideal and always has a RGB color of  $(0,0,1)$  when imaged by the camera.

a. Suppose we observe the RGB color  $(0, 0.2, 0.8)$  at a particular pixel. Give two possible foreground RGB colors and associated alpha values which would account for this observation.

b. In order to break the ambiguity, we can photograph the statue again in front of an ideal green screen. Now the observed color at this particular pixel is  $(0, 0.8, 0.2)$ . What is the correct foreground RGB color and alpha for this pixel?

8. You're sitting around talking to an artist friend of yours about colors. (You are very bored.) Unfortunately the only visual aids available are several white flashlights and some red, green, and blue color filters.

a. You suggest that red is a great color and shine a flashlight through a red filter and onto the wall to illustrate. Your artist friend says, "No.. no.. you need to 'de-saturate' that red a little, and then it will be perfect." What should you do in order to comply?

b. Next your artist friend says he'd like to see a little magenta, what should you do?

c. After hours of talking about color, all but one flashlight have dead batteries. Your friend asks for yellow. How can you accommodate?

9. A point in world space is located at  $(1,2,0)$ . Suppose we want to first move the point - 5 units on the X axis, 2 units on the Y axis, and 1 unit on the Z axis. Then we want to scale the point by 2 units in the X and Y direction and 3 units in the Z direction. Finally we rotate it by 90 degrees around the Z axis.

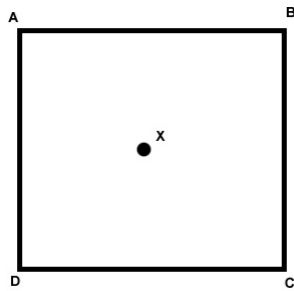
a. Write out the matrices that perform this series of operations and compute the new point.

b. Write out OpenGL code to draw this point using the above transformations.

10. A perspective camera is located at  $(1,3,1)$  looking down the positive Z axis. If the view plane is located at a distance of 3, calculate the coordinates of a point located at  $(11,8,16)$  after it has been projected onto the view plane. Ignore clipping issues.

11a. Describe the difference between Gourad and Phong shading.

11b. If we have a polygon that looks like



Positions:

A = (0,0,0)  
B = (10,0,0)  
C = (10,6,0)  
D = (0,6,0)  
X = (5,3,0)

Normals:

A=(0,1,0)  
B=(1,0,0)  
C=(0,0,1)  
D=(1,0,0)

The polygon has material property parameters:

$K_a = 1$ ,  $K_d = .2$ ,  $K_s = 0$ ,  $n_s = 5$

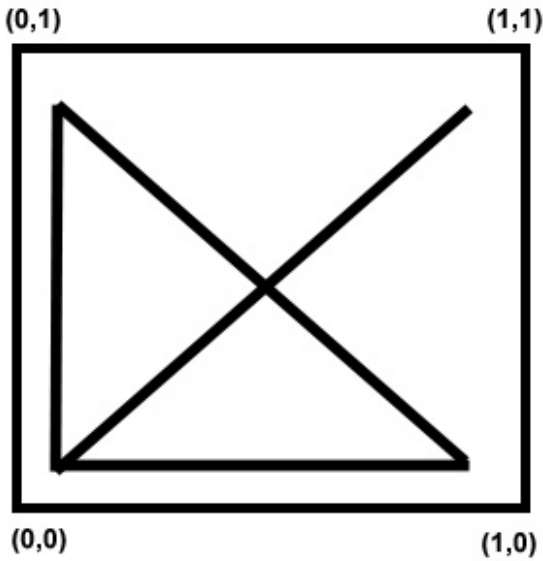
The scene world has an ambient light of RGB color (0.1,0.1,0.1)

Also there is a light located at (1,2,3) with RGB color (1,0.5,0)

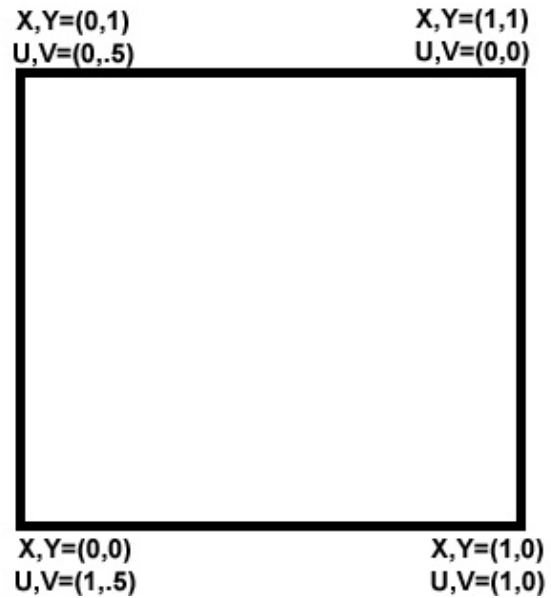
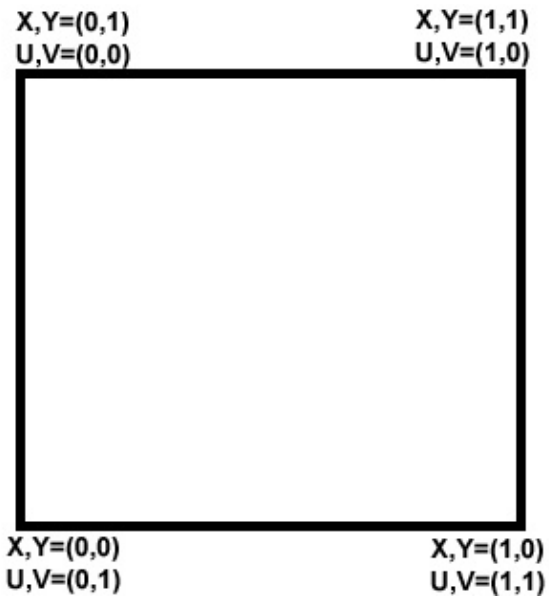
Compute the color at point X using Phong shading. When doing calculations, do not worry about normalizing vectors.

12a. Describe the difference between bump mapping and texture mapping.

12.b. This is a texture map with U,V coordinates listed.



Draw the approximate mapping on each quad if they were textured using the above image.



13.a:

Color televisions in America receive color information in YIQ space. How does a black and white TV interpret this information to display the video in appropriate shades of grey?

13b.:

Convert the following RGB colors to values in CMY color space

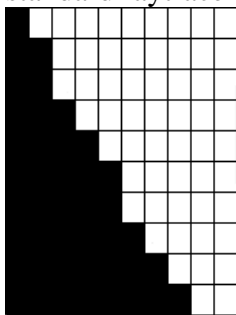
1. Blue
2. (1,1,0)
3. White

13c.

Convert the following colors in CMY color space to RGB color space.

1. Magenta
2. (1,0,1)
3. (.5,.5,.5)

14: There is a scene with one black triangle in it. When this scene is raytraced with a standard raytracer, this is the result that we get.



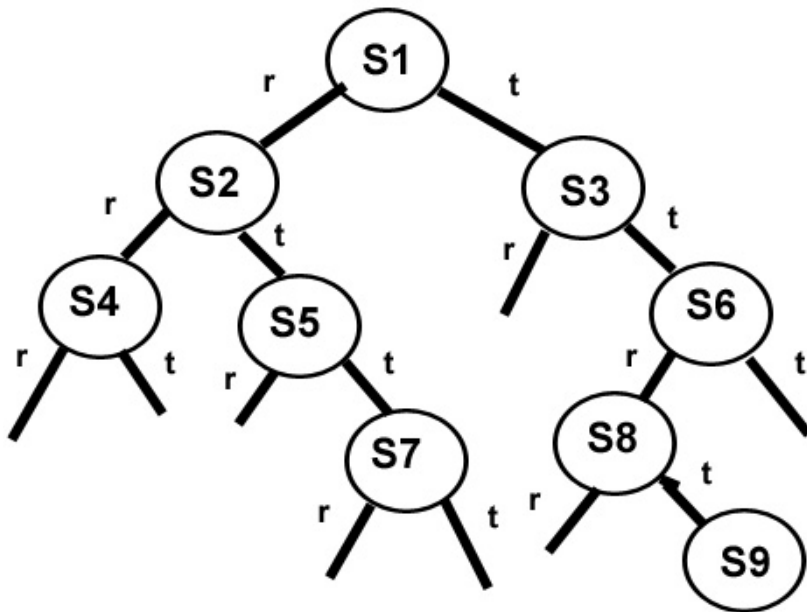
Describe what changes can be made to the **raytracing** algorithm in order to smooth out the jagged line.

15a:

Define the difference between global and local illumination.

15b:

If we generate a raytree that looks like:



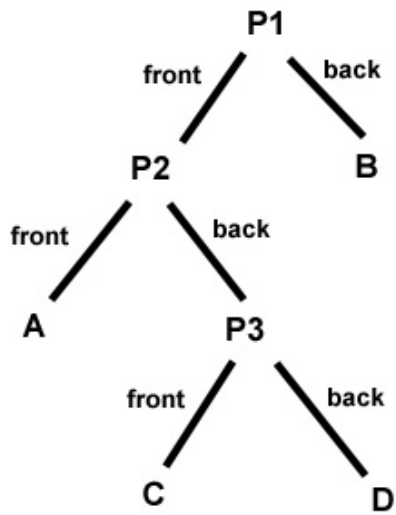
Which surfaces are reflective?

Which surfaces are refractive?

Which surfaces are neither reflective nor refractive?

16:

This is a BSP tree with front and back labeled relative to your current viewing position.



a. Draw a possible layout of objects A,B,C and D and dividing lines P1,P2 and P3 in 2d space.

b. If this BSP tree was used together with the Painter's algorithm for visibility determination, in what order would the objects be drawn?