CS 559: Computer Graphics

Homework 5

This homework must be done individually. Submission date is Tuesday, April 10, 2001, in class.

Question 1:

The rectilinear extent of a 2D polygon is the smallest rectangle that can be drawn around the polygon. Its opposing corners are (x_{min}, y_{min}) and (x_{max}, y_{max}), which x_{min} is the minimum of the x coordinates of the polygon vertices, x_{max} is the maximum of the x coordinates of the polygon vertices, and similarly for y_{min} and y_{max}. Define the *quality* of an extent as the ratio of the polygon's area to its extent's area.

a. Which visibility algorithms (hidden surface algorithms) have performance that is in some way related to the quality of the rectilinear extents of the rendered polygons? (3 points)

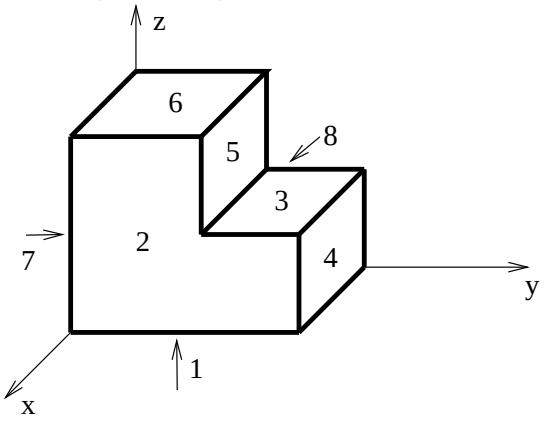
b. What shape are polygons with the highest quality extents? (2 points)

c. What shape are polygons with the lowest quality extents? (2 points)

Question 2:

This question concerns BSP trees.

a. Build the BSP tree for the object shown, where faces are used as splitting planes in the face number order. Label the nodes with split faces with sub-letters (if face 1 was to be split, the pieces would be 1a and 1b). Assume that the positive side of the splitting planes is the side that is "outside" the object. (10 points)



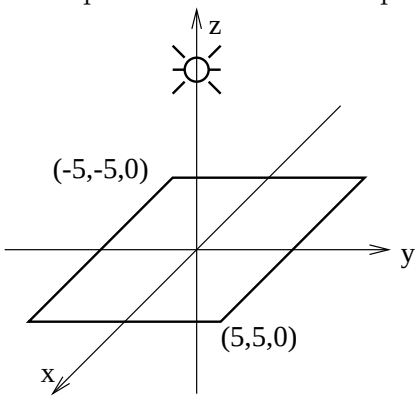
b. Build another BSP tree for the object, this time using an ordering that gives a BSP tree of lower height. You do not have to get the minimum height. Label nodes with the face numbers. (4 points)

c. Show the back-to-front rendering order for the BSP tree of part (b) if the viewer is located at (5,5,5), assuming that the object is 2 units high, 2 units wide and 1 unit deep. (6 points)

d. There are two operations that you might use a BSP tree for. One is determining the rendering order, and another is locating which "cell" of the tree the viewer is located in. Which operation performs better with a BSP tree of minimal depth, and which performs better with a BSP tree that splits the fewest faces? Why? (2 points)

Question 3:

This question explores the effect of the distant light source and distant viewer approximations. Assume you have a white point light source of intensity 1 located along the positive z axis illuminating a white square with side length 10 located in the $x - y$ plane and centered at the origin, with diffuse reflectance 0.5 and specular reflectance 0.5 with no ambient reflectance. Assume the viewer is at the point (5,0,5) looking at the origin. For these questions do not include a term for the distance from the light source to a point. The situation is pictured below.



a. Assume the light is at the point (0,0,10). What is the *diffuse* intensity at the center of the square? (4 points)

b. Again assume the light is at the point (0,0,10). What is the *diffuse* color component at a corner of the square? (4 points)

c. At what light position is the difference between the intensity at the center of the square and the intensity at the corner equal to 0.01? This could be considered a reasonable distance for the distant light assumption to be valid. (4 points)

d. Assume that the light is at (0,0,5). Where is the center of the specularity for the viewer? The center is the point where the viewer lies exactly on the reflection direction. (4 points)

e. Now assume a viewer in the direction through the point (5,0,5) but infinitely distant. What changes about the appearance of the specularity: does its center move, does its shape change, neither, both? (4 points)

f. Now assume an infinitely distant viewer, as before, and an infinitely distant light along the z axis. Is there any specularity, and if so where is it? Why? (4 points)

g. Suggest a scene that contains specular objects but for which the infinite viewer assumption would probably be acceptable. Suggest one for which it would not be acceptable. (4 points)