Final Exam - CSU540 Computer Graphics - Spring 2005

Given on April 19th 2005, Room 209 Kariotis Hall (KA)
Professor Futrelle

This is a closed book, closed notes exam. Put your answers and all your calculations in your exam book, blue or white. No calculator is needed or should be used. In drawing diagrams including fractional values, a reasonable approximation suffices. When you are asked to do a transformation step-by-step, write, draw and, comment on the results of each step. For diagrams, label all axes, coordinates, points, and vectors.

Question 1. Geometric transforms. You are not required to do any matrix multiplications in Part 1 or 2.
Part 1. Draw a 2D triangle with vertices a = 100,100; b = 200,100; c = 100,200. Draw what happens when the three transforms below are applied in the order listed. You might want to do a matrix transform of one or more of the vertices for the scaling transformation, which you might not be familiar to you. Otherwise, simply describe and draw the results at each stage.

First: A 2D scaling transform
resulting in vertices a', b', and c':

$$S = \begin{vmatrix} 3 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

Second: A translation which moves point a' to the origin
and translates the other vertices by the same amount,
yielding points a'', b'', and c''.

Third: A rotation by $\theta = -\pi/2$
yielding points a''', b''', and c'''.

Part 2. Write out the translation and rotation matrices corresponding to your description above.

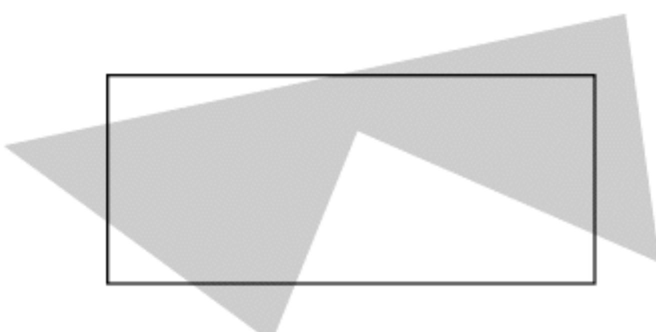
Part 3. Multiply the three matrices together, in the proper order, and apply the resultant matrix to point c, showing that it does in fact result in the transformed point being at the location c''' that you have determined in your earlier analysis.

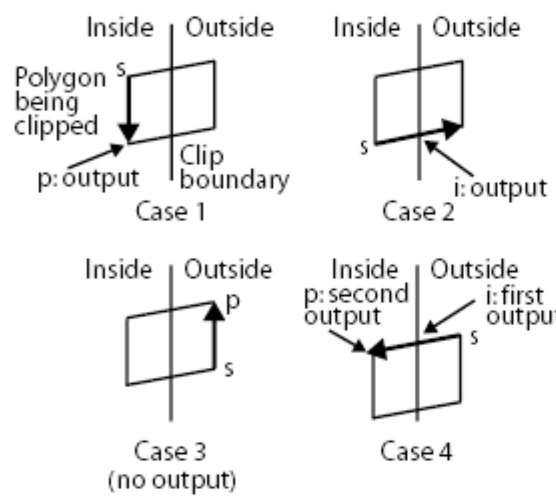
Question 2. Computing normals. Sketch a triangle as best you can, with coordinates A = 0,100,0; B = 200,0,100; C = 200,0,0.

Using two of the edges, compute a normal to the triangle. (You can choose either of the two normals.)

Write down the coordinates A', B', C' that would result from translating the triangle by 100 units in the +y direction. Then recompute the normal for this new triangle using the new vertices. Is the normal equal to the normal you computed before you translated the triangle? Do you expect it to be? Why or why not?

Question 3. Clipping polygons. The figure below, shows a polygon that is to be clipped against a rectangular window. The four cases are illustrated to the right of the polygon figure. Explain how each works. Clip the polygon in the order: bottom, top, right, and left for the window edges. Draw the successive clipping steps as separate figures.
Remember: You are constructing a new polygon for each window edge you clip against.

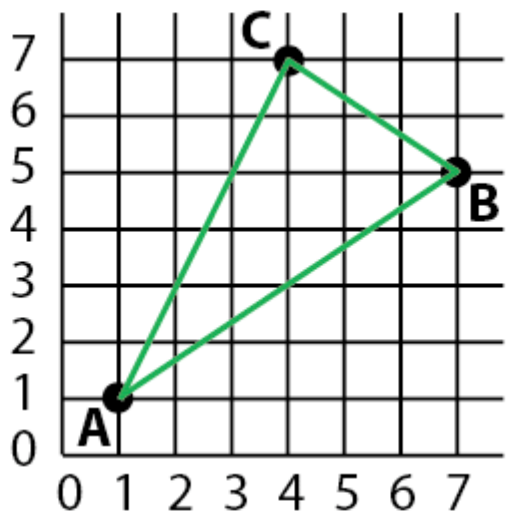


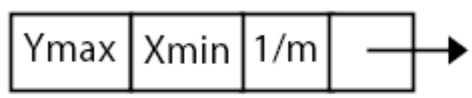


Question 4. Scan-fill of polygons. The figure below, shows the triangle **A**,**B**,**C**. To the right of it is the structure of one of the edge data elements. Do the following two tasks:

a. Build and draw the bucket-sorted edge table for the triangle, starting with y=0.

b. Show the active edge tables (AETs) for each of the y values 1 through 7, seven drawings total. In each AET update the Xmin value to the value at the corresponding value of y.





Question 5. Gouraud shading: The figure below tells you all you need to know to compute the interpolated intensity at point **D**. The point **D** is 2/3 of the way from the intersection of the scan line with the left edge to its intersection with the right edge. Use this information along with the coordinates of the three vertices and their intensities, **I**, to compute the interpolated intensity. Hint: Make sure the value you get is reasonable - don't just trust your algebra/math until you've checked it against your rough estimates and intuition.