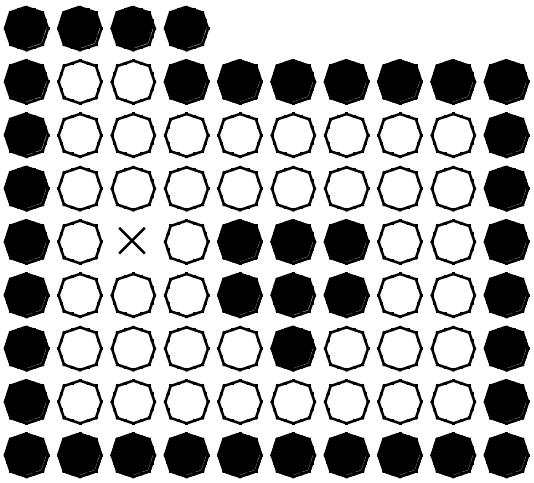
COM1370 Computer Graphics, Summer 1998

Sample questions from prior exams

Professor Futrelle, Northeastern U., College of Computer Science

The exams are closed-book, closed-notes. Please do all work in your exam book. You may take these exam questions with you when done. It is important for you to do some work on every problem -- otherwise I can't give you any partial credit.

Sample Question 1. This question focuses on scan-line, stack-based filling of pixel-bounded regions. YOU ARE TO DO YOUR WORK ON THE SEPARATE WORKSHEET FOR THIS QUESTION AND HAND IT IN WITH YOUR EXAM BOOKLET. Starting at the X, stack the left end of pixel runs and stack lower runs (lower on the page) before upper runs. Number the stacked pixels in the order stacked, through the 6th one (stop before the 7th).



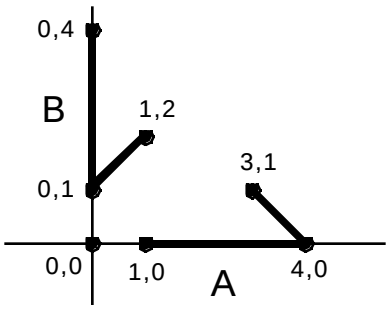
Sample Question 2. A linear transform in two dimensions is applied to A below to move it to B. A rotation R is applied first, followed by a translation T. The transforms are 3x3 matrices using homogeneous coordinates. (If you are having problems, transform the A points by R first and then transform those points by T and see if they behave properly at each stage

2a. Write out the matrix R.

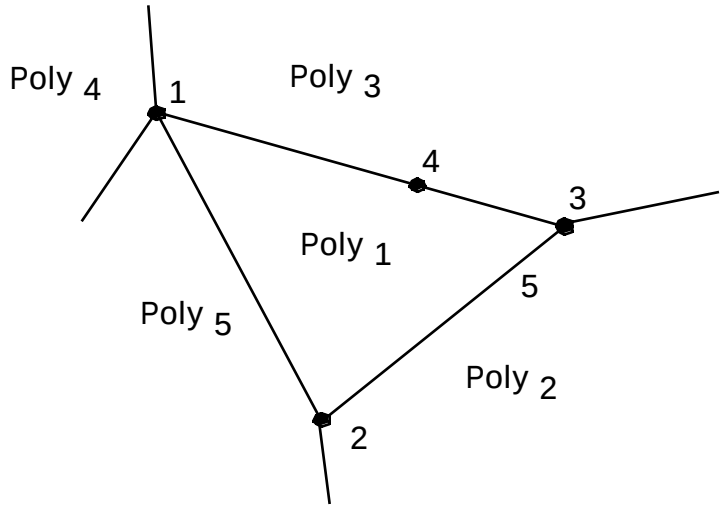
2b. Write out the matrix T.

2c. Compute and write out the product of T and R, in the correct order, as a single matrix M.

2d. Verify that M is correct by using it to transform the three points making up A and show that they correspond to the points in B.



Sample Question 3. Polygon rendering: For the 3D polygon mesh shown below, explain the difference in the computation of the intensity of point 4 for intensity interpolation (Gouraud) versus vector interpolation (Phong). You should give a detailed explanation of the principles involved as applied to this example, but you are not required to write out explicit mathematical expressions.



Sample Question 4. Two matrices for 3D rotations are given below, R_x for rotation around the x-axis and R_z for rotation around the z-axis.

$$R_x = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_x & -\sin\theta_x & 0 \\ 0 & \sin\theta_x & \cos\theta_x & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad R_z = \begin{bmatrix} \cos\theta_z & -\sin\theta_z & 0 & 0 \\ \sin\theta_z & \cos\theta_z & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

These two transformations do not commute, in general. Show this for the specific case of $\theta_x = \pi/2$ and θ_z chosen so that $\sin\theta_z = 3/5$ *and* $\cos\theta_z = 4/5$. (note for this case that $\sin^2\theta + \cos^2\theta = 1$, as it should – you don't need to figure out the value of θ_z).

A. Show that $R_X \times R_Z \neq R_Z \times R_X$ for the specific angles given above by computing the two matrix products.

B. Apply the transform R_z to the point P= (0,0,1) to produce a point P'. What do you expect the result to be and is this what you find? Then apply the transform R_x to P', producing P''. Does its position seem reasonable?

C. Apply the composite transformation that you computed in part A that is equivalent to first applying R_z and then R_x, to the point P = (0,0,1). It should produce a result equal to P''.

Sample Question 5. An "8" is constructed by joining together two cubic Bézier curves, one for the top half, the other for the bottom half. Show how the 4 points have to be arranged for each curve (two end points and two control points) so that the curves join smoothly as shown below. (The curves below were drawn with a commercial package that supports Bézier curves.) Hint: It is all right for two or more points to be at the same location in constructing these curves. You might want to draw separate pictures of the top and bottom parts to allow yourself room to show the control points.

Sample Question 6. Show the operation of the Sutherland-Hodgeman polygon clipping algorithm by clipping the triangle shown against the rectangular window. Clip against the window edges in the order left, right, bottom, top, as needed, showing the results for each edge. Remember: Always clip one edge at a time, acting as if the others weren't present.