

CS 365 Assignment 2  
Basic Operations by Hand  
Due Wednesday, 11 Feb. 2004

There are several sheets of a raster graph paper attached to this handout. You can print more off the class web page as needed. It has square pixels. Integral pixel coordinates are marked with short dotted lines in the centers of the squares, while the boundaries of the pixels, the solid lines, have half-integer coordinates.

Turn in three (or more if needed) such graphs, one for each section of this assignment. Also turn in your computations as requested.

**Line Drawing** You have a triangle with vertices  $A = (3,0)$ ,  $B = (6,9)$ ,  $C = (1,7)$ . Using an integer-computation-only version of one of the two line-drawing algorithms discussed in class (Bresenham's algorithm or the implicit line algorithm on p. 58 of your textbook), draw each of the three edges on the raster graph, as follows:

- First draw a thin line from pixel-center to pixel-center (don't shade the squares).
- If, because of the slope of the line, your algorithm is modified from the one in the book or on the web page, write down a version of the algorithm that is suited for the slope of the line you are drawing.
- Then work your algorithm for each pixel along the line. At the moment each pixel is plotted, write down the value of  $\text{eps}$  (Bresenham's algorithm) or  $d$  (implicit line algorithm) and the integral  $(x, y)$  coordinates of the plotted pixel.
- Then lightly shade in the  $(x, y)$  pixels that are plotted by algorithm.

**Implicit Line Equations** Use the triangle from above, and the implicit line equation:

$$(x_1 - x_0)y + (y_0 - y_1)x + x_0y_1 - x_1y_0 = 0$$

- Compute the distance of the points  $(3,5)$  and  $(3,6)$  from the A-B line, and write these in the  $(3,5)$  square on the raster graph.
- Compute  $\gamma$  for the points  $(3,4)$ ,  $(4,4)$ , and  $(5,4)$  and write these in the appropriate squares on the raster graph.

**Matrix Operations** For this exercise assume a triangle with vertices  $A=(0,0)$ ,  $B=(2,2)$ ,  $C=(0,4)$ . If you use the raster graph paper, you don't need to shade in squares—just draw lines with a pen or pencil as usual. For each part write down the matrix and how you derived it, and the transformed coordinates of the triangle.

- Write a  $2 \times 2$  matrix to stretch a 2D figure by a factor of 2 in both dimensions. Transform the triangle and plot it on graph paper.
- Write a  $2 \times 2$  matrix to shear a 2D figure by  $\frac{\pi}{4}$  vertically upwards. Again transform the original triangle and plot it.
- Write a  $2 \times 2$  matrix to rotate a 2D figure clockwise by  $\frac{\pi}{3}$ . Transform the original triangle, but don't plot it.
- Produce a matrix that will first shear, then stretch, then rotate a 2D figure according to the above. Transform the original triangle and plot it.
- Sketch (no need to compute it in detail) what would happen if you rotated, then sheared, then stretched the original triangle.