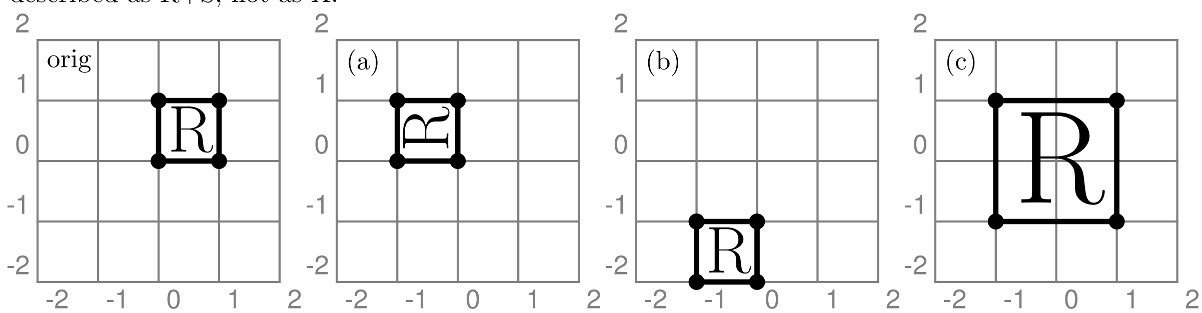
CS 230, Quiz 4

Solutions

You will have **8** minutes to complete this quiz. No books, notes, or other aids are permitted. **There is another problem on the back.**

Problem 1 (3 points)

A square with a letter (shown in the diagram labeled "orig" below) is transformed into each of the configurations (a)-(c). In each case, identify the type of transform and, if possible, find a 3×3 homogeneous transform matrix corresponding to it. In each case, identify the transform as a R=rotation, T=translation, S=uniform scale, X=none of these. R, S, and T can be combined. The most restrictive option should be chosen. Thus, a transform that can be accomplished by a combination of rotation and uniform scale should be described as R+S, not as X.



(a) R. $\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(b) T. $\begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{pmatrix}$

(c) S+T. $\begin{pmatrix} 2 & 0 & -1 \\ 0 & 2 & -1 \\ 0 & 0 & 1 \end{pmatrix}$

Problem 2 (1 points)

What does the 4×4 homogeneous transform matrix $\mathbf{M}$ do?

$$\mathbf{M} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{pmatrix}$$

This problem is actually a little tricky, since we have not discussed the effects of putting something other than 1 in the bottom right. Nevertheless, we can simply examine how it changes a point (x, y, z).

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix} = \begin{pmatrix} x \\ y \\ z \\ 2 \end{pmatrix} \equiv \begin{pmatrix} \frac{x}{2} \\ \frac{y}{2} \\ \frac{z}{2} \end{pmatrix}$$

This matrix behaves as a uniform scale by $\frac{1}{2}$. Indeed, since scaling a homogeneous point makes no difference (since we will eventually divide off the w), scaling a transformation also makes no difference.

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{pmatrix} \equiv \begin{pmatrix} \frac{1}{2} & 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 & 0 \\ 0 & 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

This is the form we would expect from a scale matrix.