

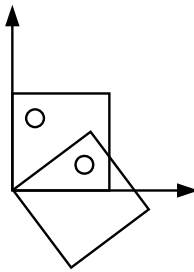
CS 465 Solution 4

(revised October 4, 2004)

Problem 6: 2D Transformations

1. Rotation by $\theta = (270 + 2 * 18.43)$ degrees or by $\theta = -(90 - 2 * 18.43)$ degrees around the point $(0, 0)$

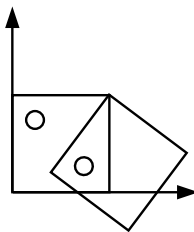
$$R = \begin{bmatrix} \cos(53.14^\circ) & \sin(53.14^\circ) & 0 \\ -\sin(53.14^\circ) & \cos(53.14^\circ) & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0.6 & 0.8 & 0 \\ -0.8 & 0.6 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



2. Rotation of $\theta = (90 - 2 * 18.43)$ degrees around the point $(1, 1)$. $M = T(1, 1)R(53.14)T(-1, -1)$

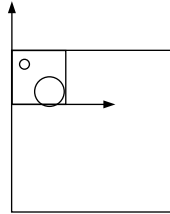
$$M = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(53.14^\circ) & -\sin(53.14^\circ) & 0 \\ \sin(53.14^\circ) & \cos(53.14^\circ) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & -0.8 & 1.2 \\ 0.8 & 0.6 & -0.4 \\ 0 & 0 & 1 \end{bmatrix}$$



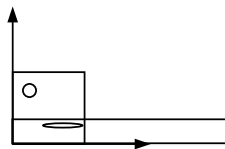
3. Uniform Scale of 3 around the point (0,1). $M = T(0,1)S(3,3)T(0,-1)$

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & -2 \\ 0 & 0 & 1 \end{bmatrix}$$



4. Non Uniform Scale of 3 in x and $\frac{1}{3}$ in y.

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



5. Shear of 1 along the axis given by $y = -x$. $M = R(-45)Sh(1)R(45)$

$$M = \begin{bmatrix} \cos(45^\circ) & \sin(45^\circ) & 0 \\ -\sin(45^\circ) & \cos(45^\circ) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(45^\circ) & -\sin(45^\circ) & 0 \\ \sin(45^\circ) & \cos(45^\circ) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \frac{1}{2} \begin{bmatrix} 3 & 1 & 0 \\ -2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

