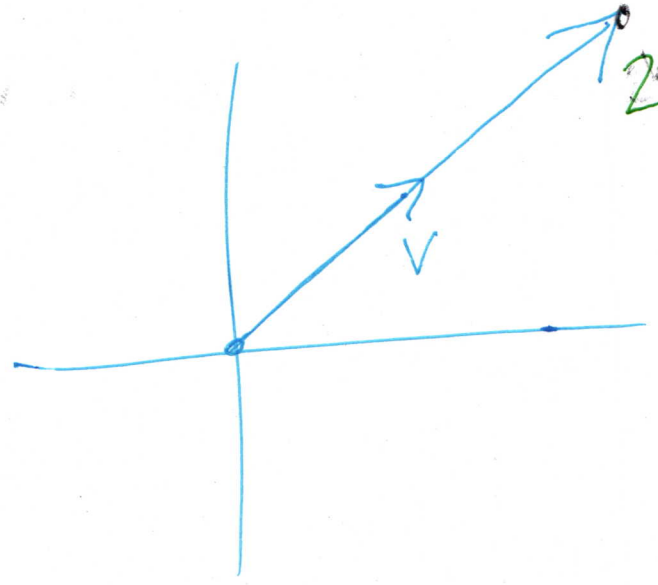
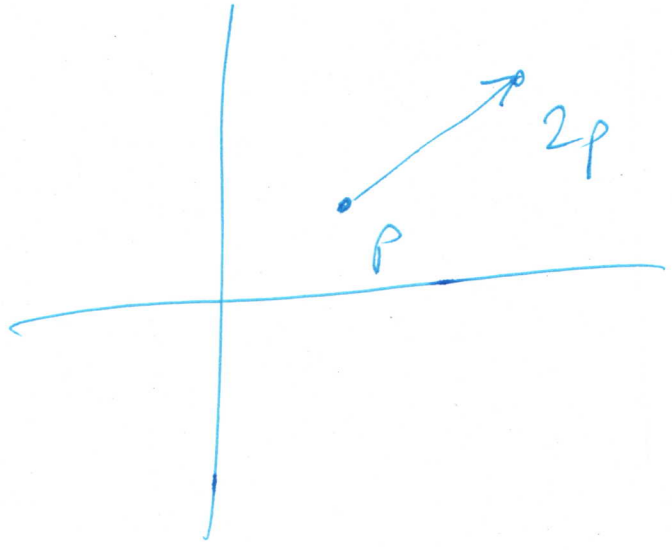
2/25 Slide 1



SCALING



point-

Slide 2

$$M_s = \left[\begin{array}{cc|c} s & 0 & 0 \\ 0 & s & 0 \\ \hline 0 & 0 & 1 \end{array}\right]$$

$$M_s v = \left[\begin{array}{cc|c} s & 0 & 0 \\ 0 & s & 0 \\ \hline 0 & 0 & 1 \end{array}\right] \left[\begin{array}{c} v_x \\ v_y \\ \hline 1 \end{array}\right]$$

$\sqrt{}$ (vector?)

point

$$= \begin{bmatrix} sv_x + 0v_y + 0 \cdot 1 \\ 0v_x + sv_y + 0 \cdot 1 \\ 0v_x + 0v_y + 1 \end{bmatrix}$$

$$= \begin{bmatrix} sv_x \\ sv_y \\ 1 \end{bmatrix}$$

Slide 3

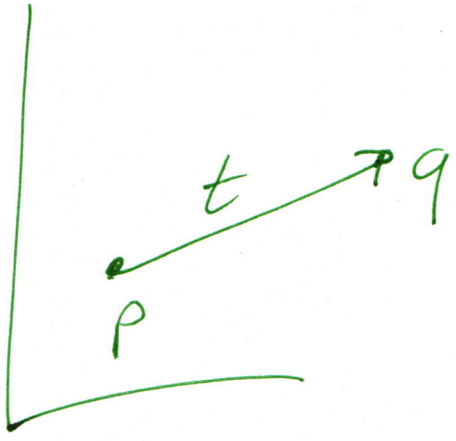
$$M_S = \begin{bmatrix} s & 0 & 0 \\ 0 & s & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_x \\ v_y \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} sv_x \\ sv_y \\ 0 \end{bmatrix}$$

Sl. 4

$$q = p + t$$

$$M_s\, q = M_s(p + t)$$



$$q' = q + t'$$

$$q'' = M_s(q + t')$$

$$= M_s(M_s(p + t) + t)$$

- - -

$$Q' = M_s M_t P$$

$$= \left[\begin{array}{ccc} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{array}\right] \left[\begin{array}{ccc} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{array}\right]$$

$$= \begin{bmatrix} s_x & 0 & s_x t_x \\ 0 & s_y & s_y t_y \\ 0 & 0 & 1 \end{bmatrix}$$

$$M = M_t M_s = \begin{bmatrix} s_x & 0 & t_x \\ 0 & s_y & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

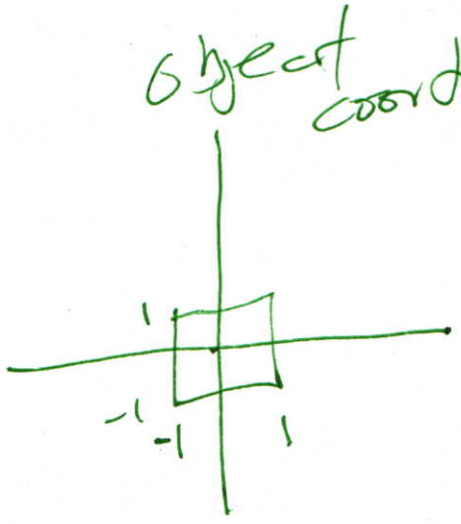
$$M_t = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} P_x \\ P_y \\ 1 \end{bmatrix}$$

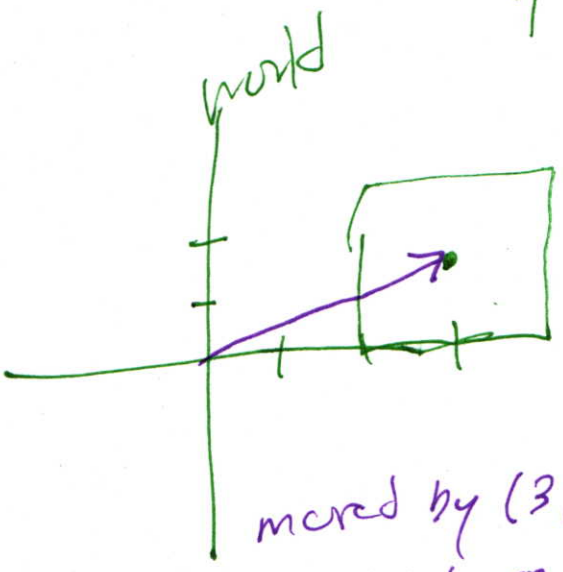
$$= \begin{bmatrix} P_x + t_x \\ P_y + t_y \\ 1 \end{bmatrix}$$

$$q' = M_s M_t P$$

$$q' = M_s M_t$$

$$= \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$





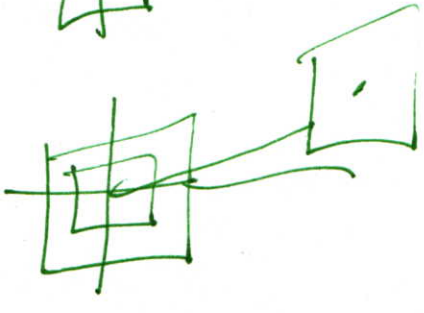
moved by (3,1)
scaled by (2,2)

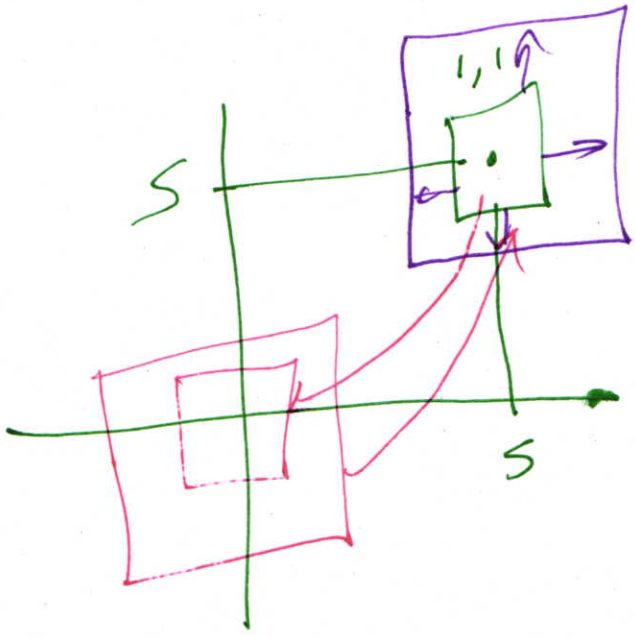
$$M_{T(3,1)} = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M_{S(2,2)} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M = M_{(2,2)} M_{T(3,1)}$$

$$M = M_{T(3,1)} M_{(2,2)}$$

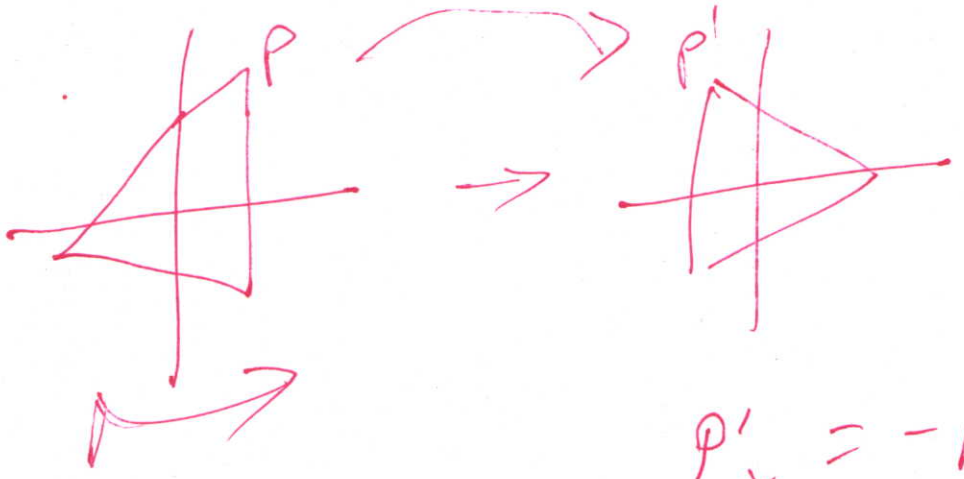




scale in place

$M_{T(S,S)}\, M_{S(2)}\, M_{T(-S,-S)}$

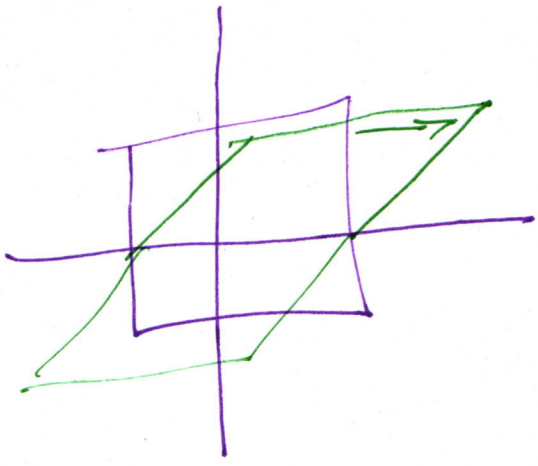
Translate inverse
Scale
Translate



$$P'_x = -P_x$$

$$M^{2D}_{Reflect(x)} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Shear



$$M_{shear} = \begin{bmatrix} 1 & hx & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} x + hxy \\ y \\ 1 \end{bmatrix}$$

$$M^{2D}_{R(\theta)} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

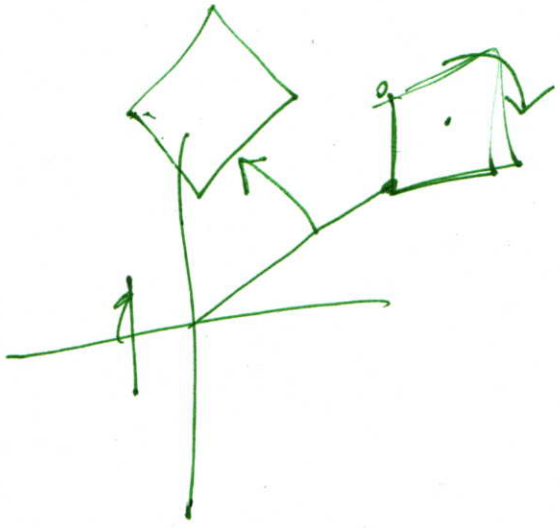
$$\begin{bmatrix} x\cos\theta - y\sin\theta \\ x\sin\theta + y\cos\theta \\ 1 \end{bmatrix}$$

$$M_{R(0)} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M_{R(45^\circ)} =$$

$$M = M_{R_z(\beta)}\, M_{R_y(\varphi)}\, M_{R_x(\theta)}$$

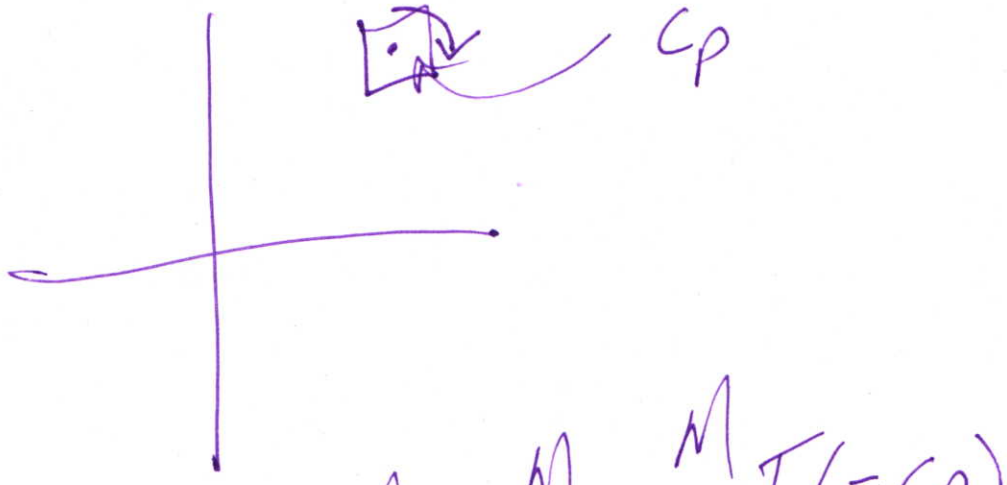
β, φ, θ



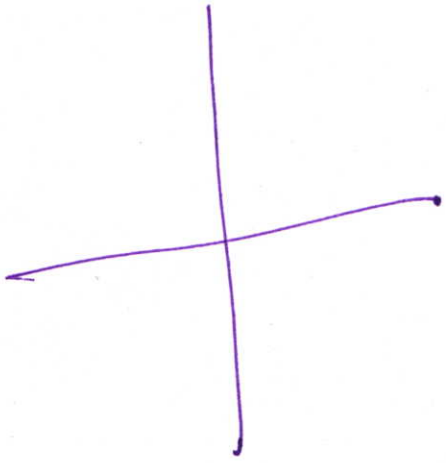
$M_{R(\theta)}\left[\square\right]$

45°

$$M_{R(\theta)} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$$M = M_{T(cp)} M_{R(45)} M_{T(-cp)}$$



$$M_S = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M_{R(\theta)} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M_S M_{R(\theta)} \stackrel{?}{=} M_{R(\theta)} M_S$$