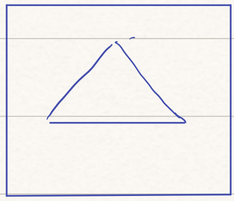
Normalized Device Coordinates (NDC)

given some immediate mode, vertices in 2D (0, 0.5)
(0.5, -0.25)
(0.5, 0.25)



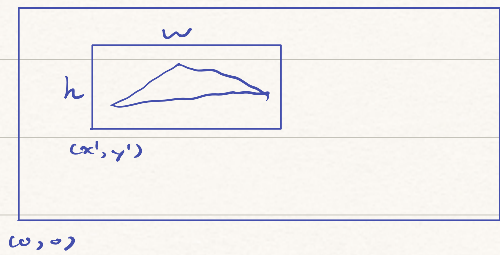
← the range of this triangle -1 to 1 is NDC

when we're drawing screen, we have to draw to frame buffer, which is the raster image to display, a 2D-grid of picture in memory. Frame buffer exist on screen space and defined in screen space. Viewport defines the transfrom from normalized coordinate to screen space. i.e. $(0,0) \to (\frac{w}{2}, \frac{h}{2})$

opened drawable window $(x, y) \to (\frac{(x+1)w}{2}, \frac{(y+1)h}{2})$

To draw on the window which has the offset (x', y'), we have

$(x, y) \to (\frac{(x+1)w}{2} + x', \frac{(y+1)h}{2} + y')$



Affine Transform.

Affine: 1) Straight lines are preserve

2) Parallelizm is preserved i.e. transform is same scale.

Scale: keep ratio, but scale up/down $\begin{pmatrix} x \\ y \end{pmatrix} \to \begin{pmatrix} s_x x \\ s_y y \end{pmatrix}$

* we usually transform vertices only, not all objects.

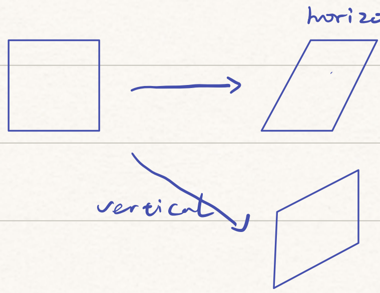
this mapping is achieved via matrix mulplication,

$\begin{pmatrix} x \\ y \end{pmatrix} \cdot \begin{pmatrix} s_x & 0 \\ 0 & s_y \end{pmatrix} = \begin{pmatrix} s_x x \\ s_y y \end{pmatrix}$

so, x only: $\begin{pmatrix} s_x & 0 \\ 0 & 1 \end{pmatrix}$, y only: $\begin{pmatrix} 1 & 0 \\ 0 & s_y \end{pmatrix}$.

scaling is reversable. To get it reversed, multiply by
$\begin{pmatrix} \frac{1}{s_x} & 0 \\ 0 & \frac{1}{s_y} \end{pmatrix}$

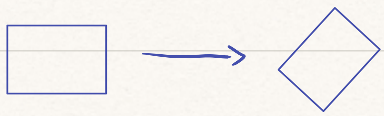
shear:

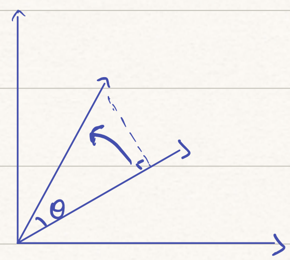


$\begin{pmatrix} 1 & m \\ 0 & 1 \end{pmatrix}$

$\begin{pmatrix} 1 & 0 \\ m & 1 \end{pmatrix}$

rotation



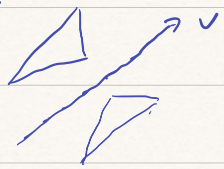


$\begin{pmatrix} x \\ y \end{pmatrix} \begin{pmatrix} \cos\theta, & \sin\theta \\ \sin\theta, & \cos\theta \end{pmatrix} = \begin{pmatrix} x' \\ y' \end{pmatrix}$

the inverse of this rotation is to rotate back (clockwise)

$\begin{pmatrix} \cos\theta, & \sin\theta \\ \sin\theta, & \cos\theta \end{pmatrix}^{-1} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$

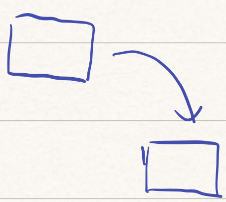
reflection



$\vec{v} = \begin{pmatrix} v_x \\ v_y \end{pmatrix}$ $\begin{pmatrix} x \\ y \end{pmatrix} \begin{pmatrix} v_x^2 - v_y^2 & 2v_x v_y \\ 2v_x v_y & v_y^2 - v_x^2 \end{pmatrix}$

the inverse is exactly same

translation



just move it! $\begin{pmatrix} x + dx \\ y + dy \end{pmatrix}$

([illegible])
Homogenins coordinates

point: $\begin{pmatrix} x \\ y \end{pmatrix} \longrightarrow \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$

direction: $\begin{pmatrix} dx \\ dy \end{pmatrix} \longrightarrow \begin{pmatrix} dx \\ dy \\ 0 \end{pmatrix}$

$\begin{pmatrix} x \\ y \\ 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & dx \\ 0 & 1 & dy \\ 0 & 0 & 1 \end{pmatrix}$.