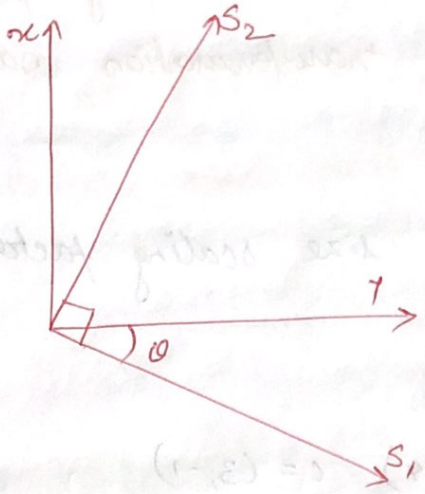
General Scaling Direction



- Parameter s_x & s_y scale the object along x & y directions. we can scale an object in other directions by rotating the object to align the desired scaling direction with the co-ordinate axes before applying the scaling transformation.
- Suppose we apply scaling factor S_1 & S_2 in direction shown in figure then we will apply following transformations.

1. Perform a rotation so that the direction for S_1 & S_2 coincide with x & y axes.
2. scale the object with specified scale factor.
3. Perform opposite rotation to return points to their original orientations (i.e. inverse of step-1)

. The matrix representation is:

$$P' = R^{-1}(\theta)\,[\,S(s_1, s_2) \cdot \{R(\theta) \cdot P\}\,]$$

$$= \{R^{-1}(\theta) \cdot S(s_1, s_2) \cdot R(\theta)\} \cdot P$$

$$= \begin{bmatrix} \cos(-\theta) & \sin(-\theta) & 0 \\ -\sin(-\theta) & \cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot P$$

$$= \begin{bmatrix} s_1\cos^2\theta + s_2\sin^2\theta & (s_2 - s_1)\cos\theta\sin\theta & 0 \\ (s_2 - s_1)\cos\theta\sin\theta & s_1\sin^2\theta + s_2\cos^2\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot P$$

Here P' & P are column vector of final & initial point co-ordinate respectively and θ is the angle between actual scaling direction and our standard co-ordinate axes.