## Examples of common geometric transformations

**Translation by** $(\alpha, \beta)$

$$x = x + \alpha$$
$$y = y + \beta$$

**Rotation (counter clockwise) by** $\alpha$ **around** $(0, 0)$

$$x = x\cos\alpha - y\sin\alpha$$
$$y = x\sin\alpha + y\cos\alpha$$

**Rotation (counter clockwise) by** $\alpha$ **around** $(c_x, c_y)$

$$x = (x - c_x)\cos\alpha - (y - c_y)\sin\alpha + c_x$$
$$y = (x - c_x)\sin\alpha + (y - c_y)\cos\alpha + c_y$$

**Scaling by** $s$ **around** $(0, 0)$

$$x = sx$$
$$y = sy$$

**Scaling by** $s$ **around** $(c_x, c_y)$

$$x = s(x - c_x) + c_x$$
$$y = s(y - c_y) + c_y$$

**Affine** Affine transformation is the most general transformation that preserves lines and ratios of distances of points on a line.

$$x = a_x x + b_x y + c_x$$
$$y = a_y x + b_y y + c_y$$

**Perspective Projection**

$$x = \frac{a_x x + b_x y + c_x}{A_x x + B_x y + C_x}$$

$$y = \frac{a_y x + b_y y + c_y}{A_y x + B_y y + C_y}$$