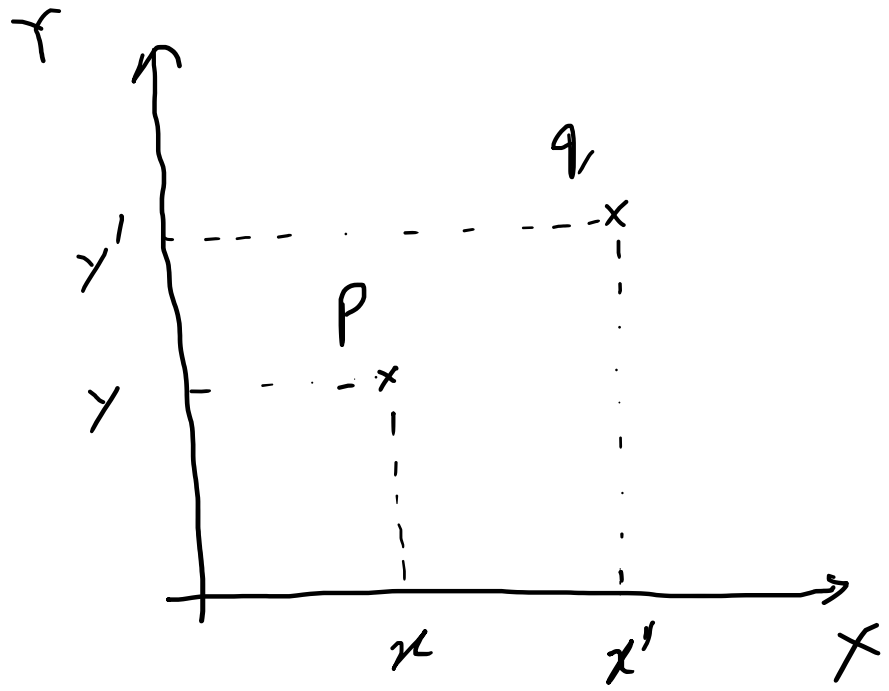
IMAGE WARPING

FORWARD & BACKWARD

Translation



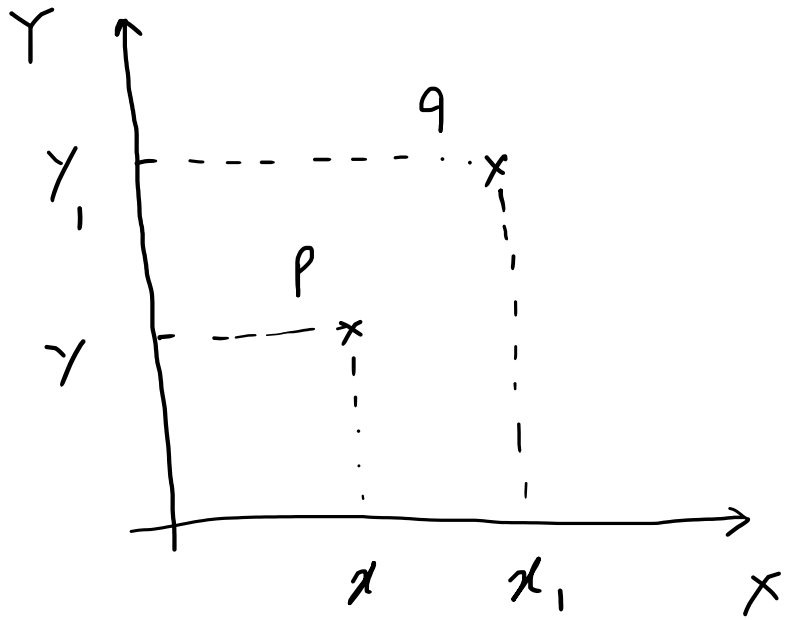
$$x' = x + t_x$$

$$y' = y + t_y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Scaling



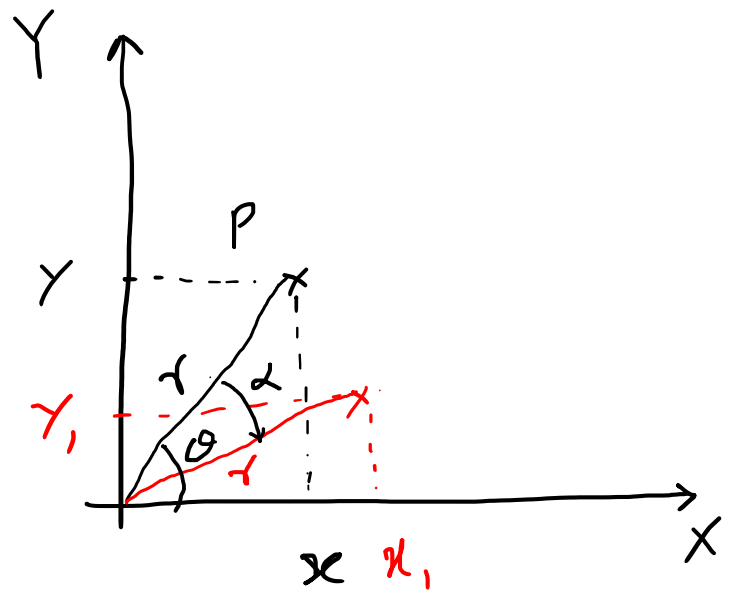
$$x_1 = c_x \, x$$

$$y_1 = c_y \, y$$

$$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} c_x & 0 \\ 0 & c_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} c_x & 0 & 0 \\ 0 & c_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Rotation



$$x = r\cos\theta$$

$$y = r\sin\theta$$

$$x_1 = r\cos(\theta-\alpha)$$

$$y_1 = r\sin(\theta-\alpha)$$

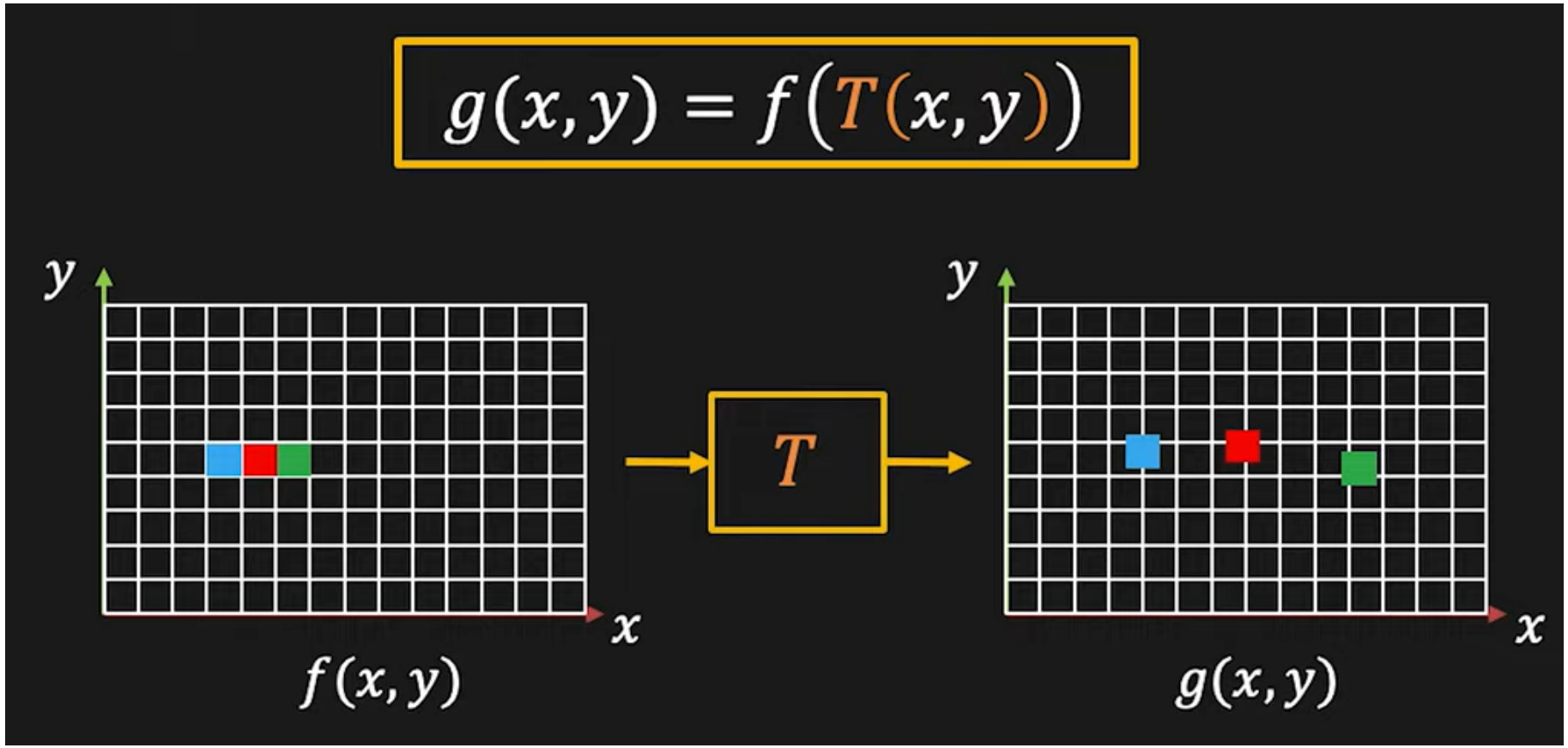
$$x_1 = r\cos\theta\cos\alpha + r\sin\theta\sin\alpha$$

$$x_1 = x\cos\alpha + y\sin\alpha$$

$$y_1 = y\cos\alpha - x\sin\alpha$$

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

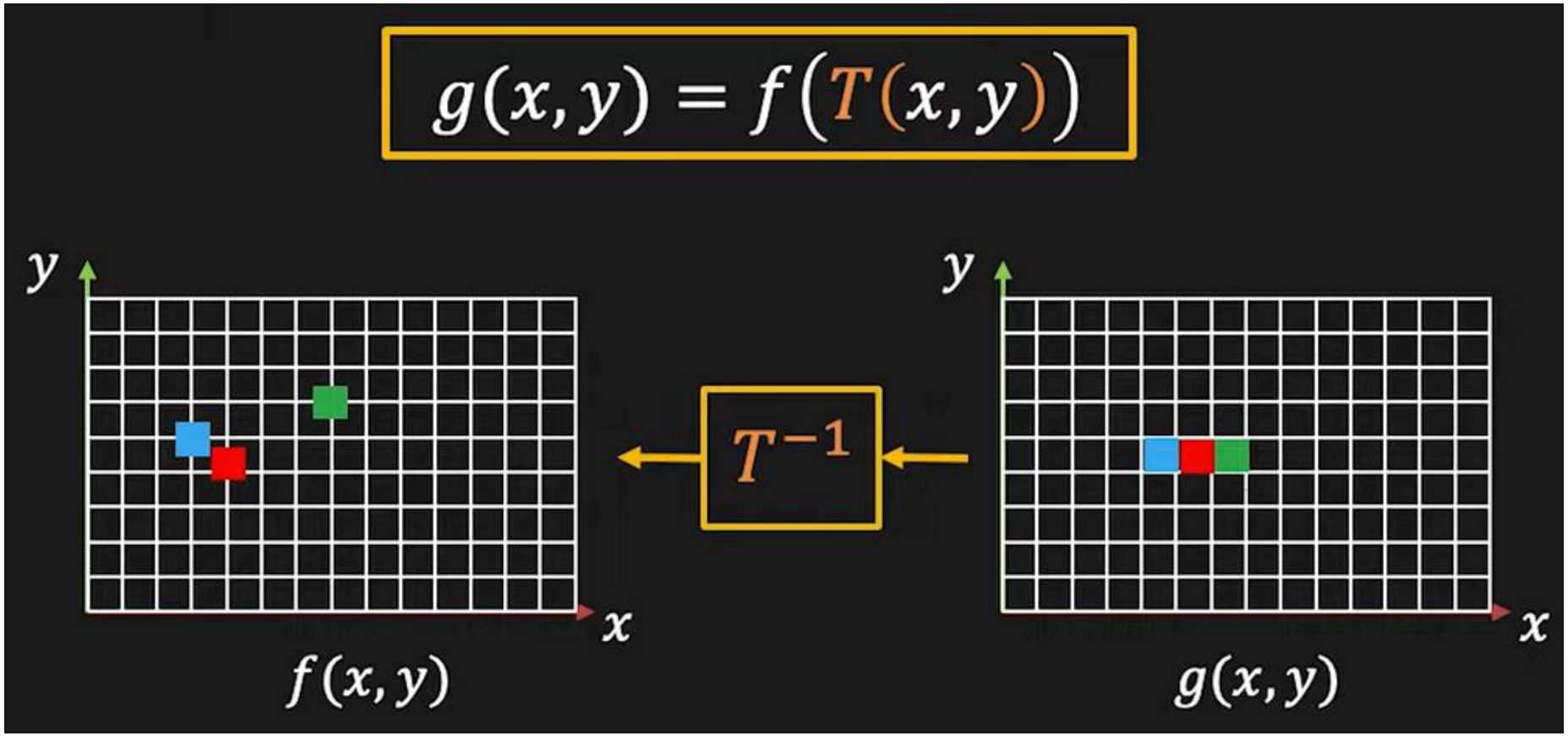
FORWARD WARPING



FORWARD WARPING ALGO

- Define input image
- Declare forward transfer function
- Initialize output image (Same size of input or different depending on application, all elements 0 or 1)
- Map the four corners from input to output while applying forward transfer function
- Apply forward transfer function on all coordinates of input image and get nearest integer location (x as well as y) in output image
- Apply interpolation if holes are encountered in output image

BACKWARD WARPING



BACKWARD WARPING ALGO

- Define input image
- Calculate backward transfer function from declared forward transfer function
- Initialize output image (Same size of input or different depending on application, all elements 0 or 1)
- Map the four corners from input to output while applying forward transfer function
- Apply backward transfer function on all coordinates of output image and get nearest integer location (x as well as y) in input image
- Apply interpolation for more precision if x and/or y coordinates are non-integer after applying backward transfer function

ROTATION

ORIGINAL

90 DEGREE

45 DEGREE