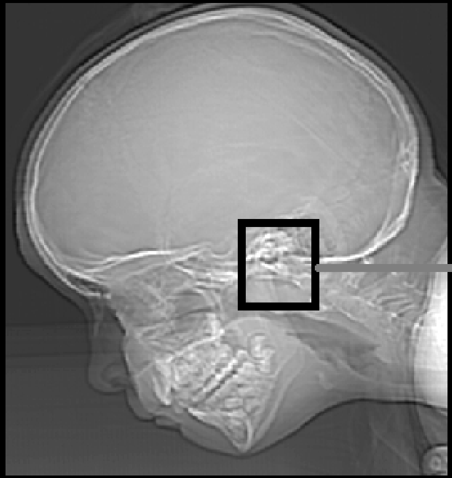
Geometric Operations

Geometric Operations

Geometric operations transform or modify the geometry of an image by changing the position of pixels. Geometric Operations do not change the value of pixel's intensity but change the spatial relationship between the pixels.

How does Computer see the image ?

Gray Scale Image



What we see

255	255	238	30	62	241	255
255	255	218		64	241	255
255	255	145		64	241	255
255	255	81		72	244	255
255	255	72		128	255	255
255	255	73		146	255	255
255	255	64	[illegible]	184	255	255
255	255	63	[illegible]	188	255	255

What computer sees

Spatial Domain Representation of an Image

An Image of size $M \times N$ can be spatially represented by the following way

$$I(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & \dots & f(1,N-1) \\ \vdots & \vdots & \ddots & \vdots \\ f(M-1,0) & f(M-1,1) & \ddots & f(M-1,N-1) \end{bmatrix}$$

Translation

Translation is the shifting of pixel's location in the (x, y) direction.
If $\boxed{I(x, y)}$ is the input image which is displaced in the direction (x, y) then (T_x, T_y) represents the amount of shift in the x and y direction respectively.
The shifted Image is $\boxed{J(x', y')}$.

where

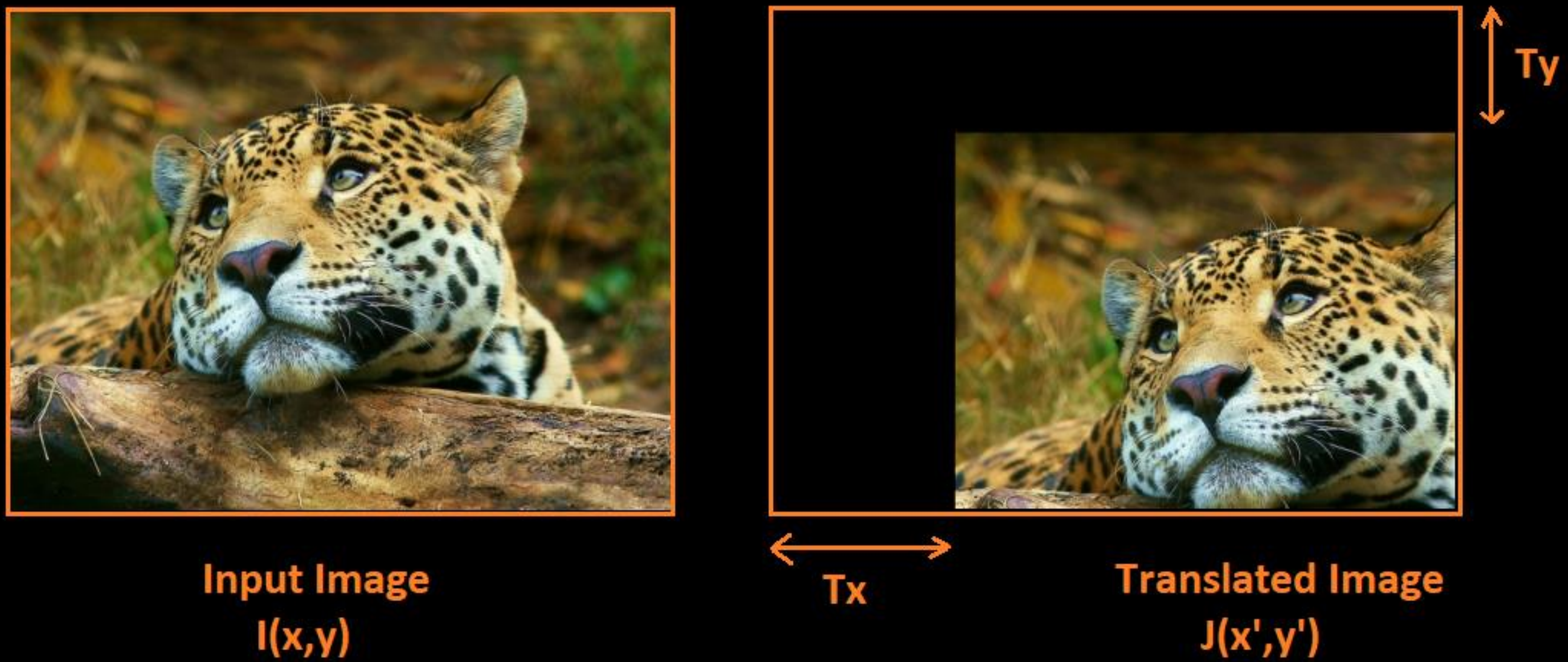
$$\boxed{\begin{aligned} x' &= x + T_x \\ y' &= y + T_y \end{aligned}}$$

Translation

The translation matrix T is given by

$$\boxed{T = \begin{bmatrix} 1 & 0 & T_x \\ 0 & 1 & T_y \end{bmatrix}}$$

where,
T_x = represents shift in horizontal direction (x-direction)
T_y = represents shift in vertical direction (y-direction)


Ty
Tx
Input Image
I(x,y)
Translated Image
J(x',y')

Rotation

Rotation of an image through an angle θ could be performed by the following Rotation matrix.

$$\boxed{R = \begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{bmatrix}}$$

where

$\theta =$ angle of rotation

Input Image

Image Rotated by 90 degree

Affine Transformation

In affine transformation, parallel lines in the original image will still be parallel in the output image. To find the transformation matrix, we need three points from the input image and their corresponding locations in the output image.

Original Image

Transformed Image