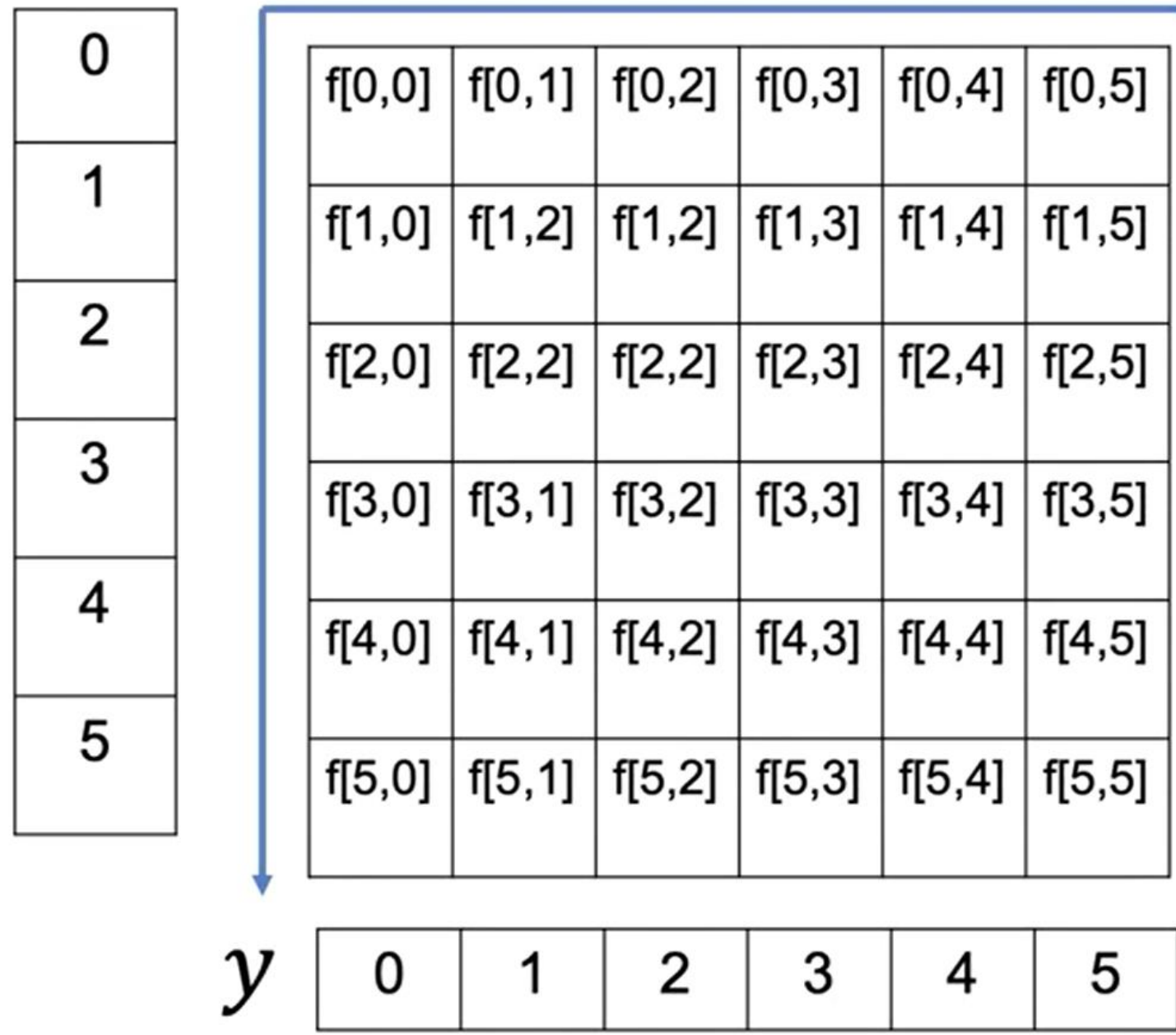
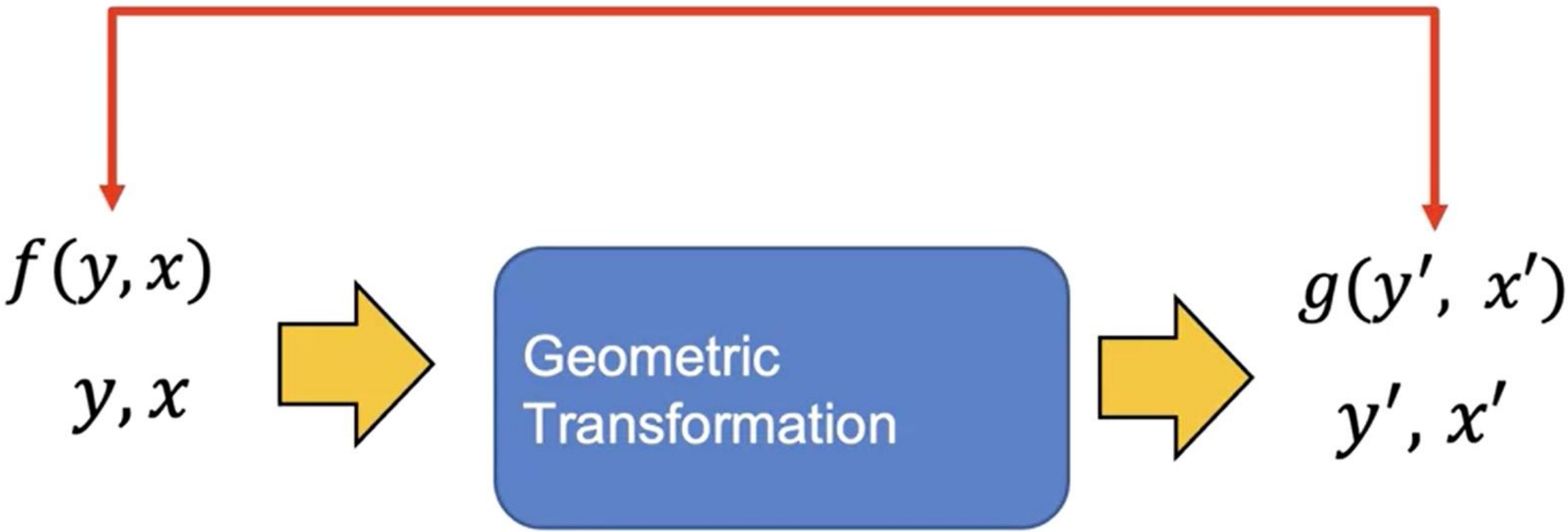
Week 3 – Geometric Operations

Geometric Operations

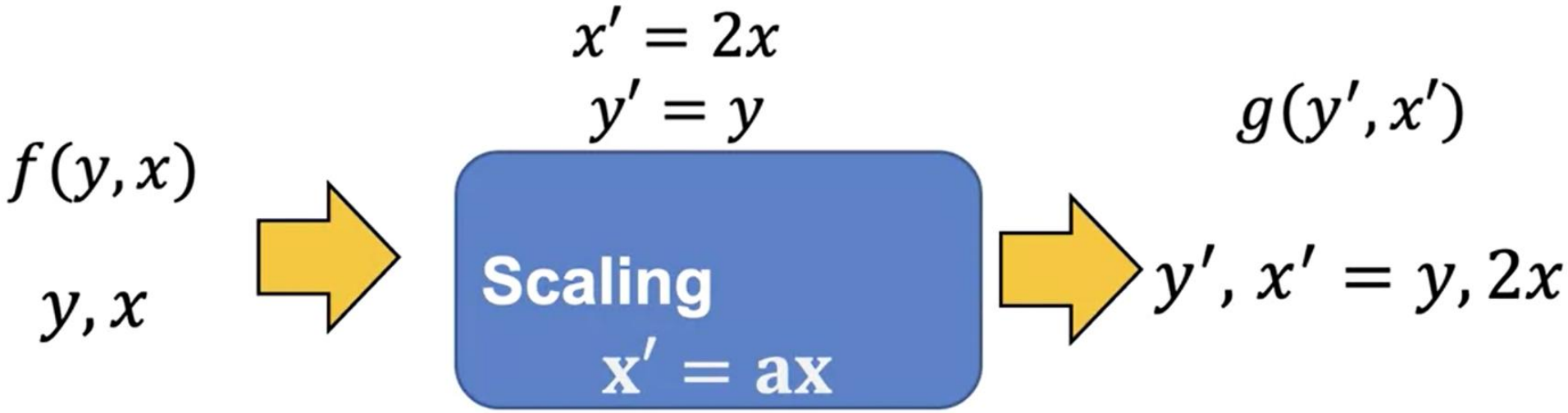
- Scaling
- Translation
- Rotation

$f(y, x)$


x
0
1
2
3
4
5
f[0,0] f[0,1] f[0,2] f[0,3] f[0,4] f[0,5]
f[1,0] f[1,2] f[1,2] f[1,3] f[1,4] f[1,5]
f[2,0] f[2,2] f[2,2] f[2,3] f[2,4] f[2,5]
f[3,0] f[3,1] f[3,2] f[3,3] f[3,4] f[3,5]
f[4,0] f[4,1] f[4,2] f[4,3] f[4,4] f[4,5]
f[5,0] f[5,1] f[5,2] f[5,3] f[5,4] f[5,5]
y
0 1 2 3 4 5


$f(y, x)$
y, x
Geometric Transformation
$g(y', x')$
y', x'

Scaling



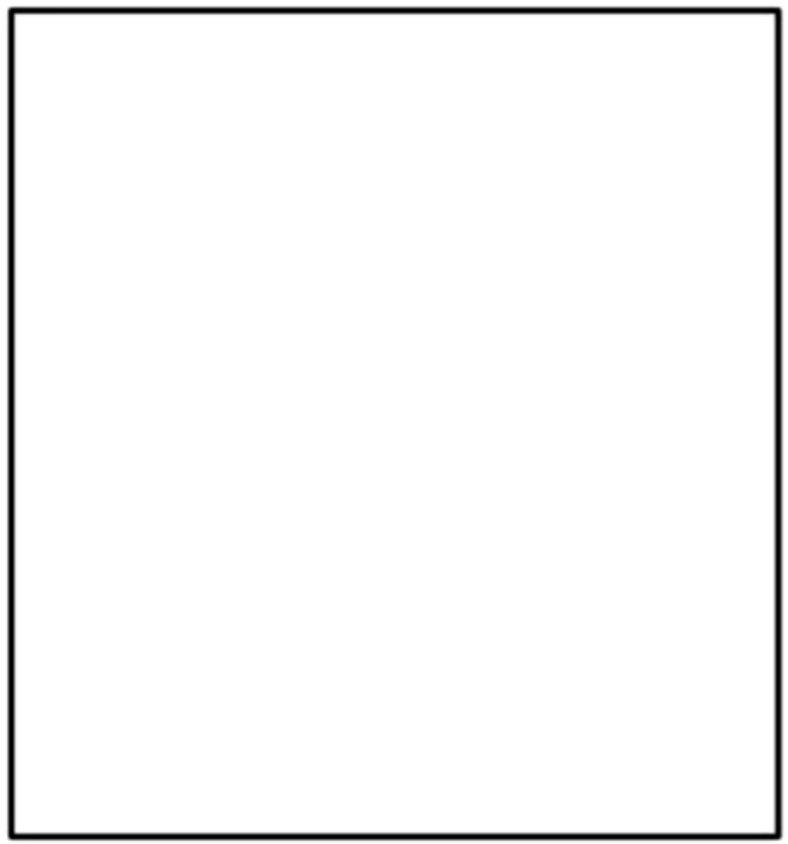
$$g(y, 2x) = f(y, x)$$

$x' = ax$ $x' = 2x$

$x' = 2(0) = 0$

$f[0,0]$

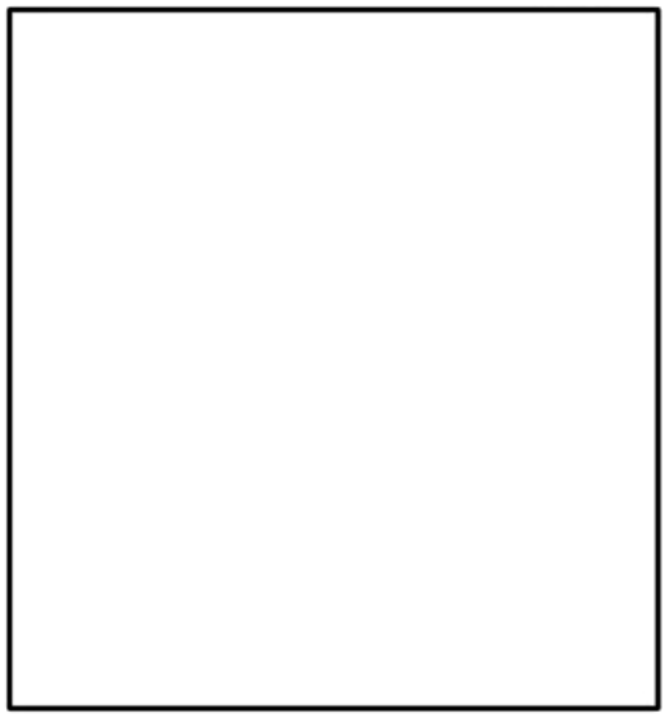
$g[0,0]$



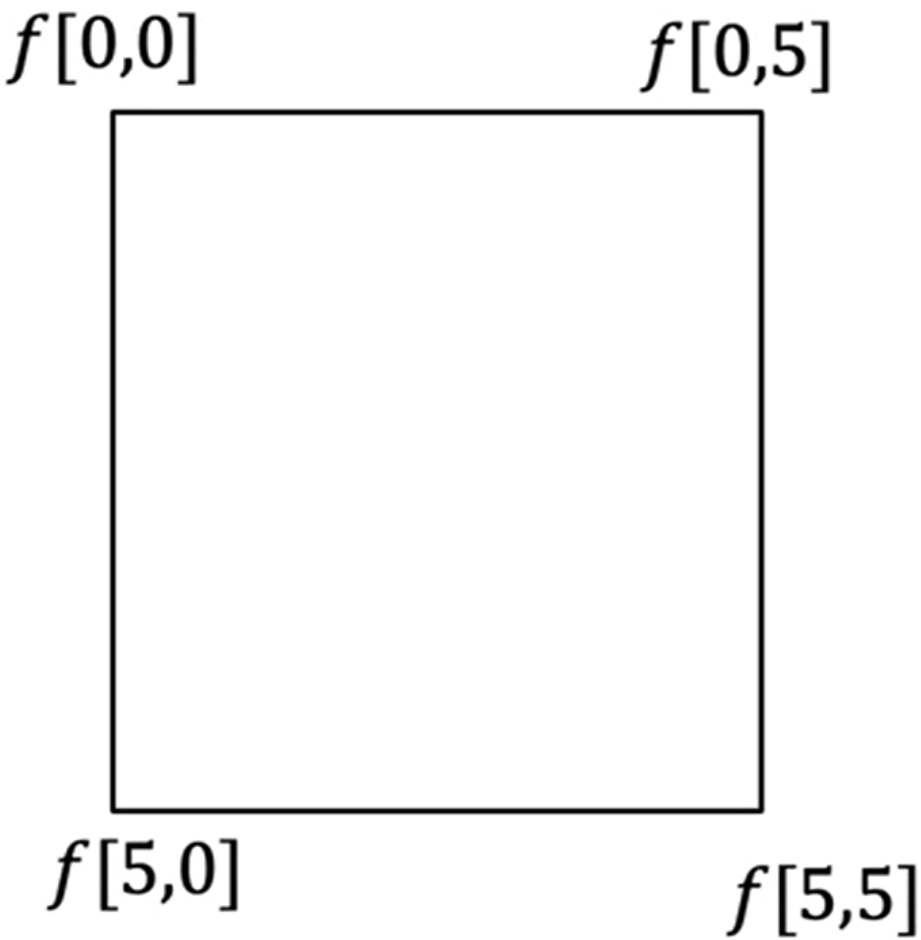
$x' = ax$ $x' = 2x$

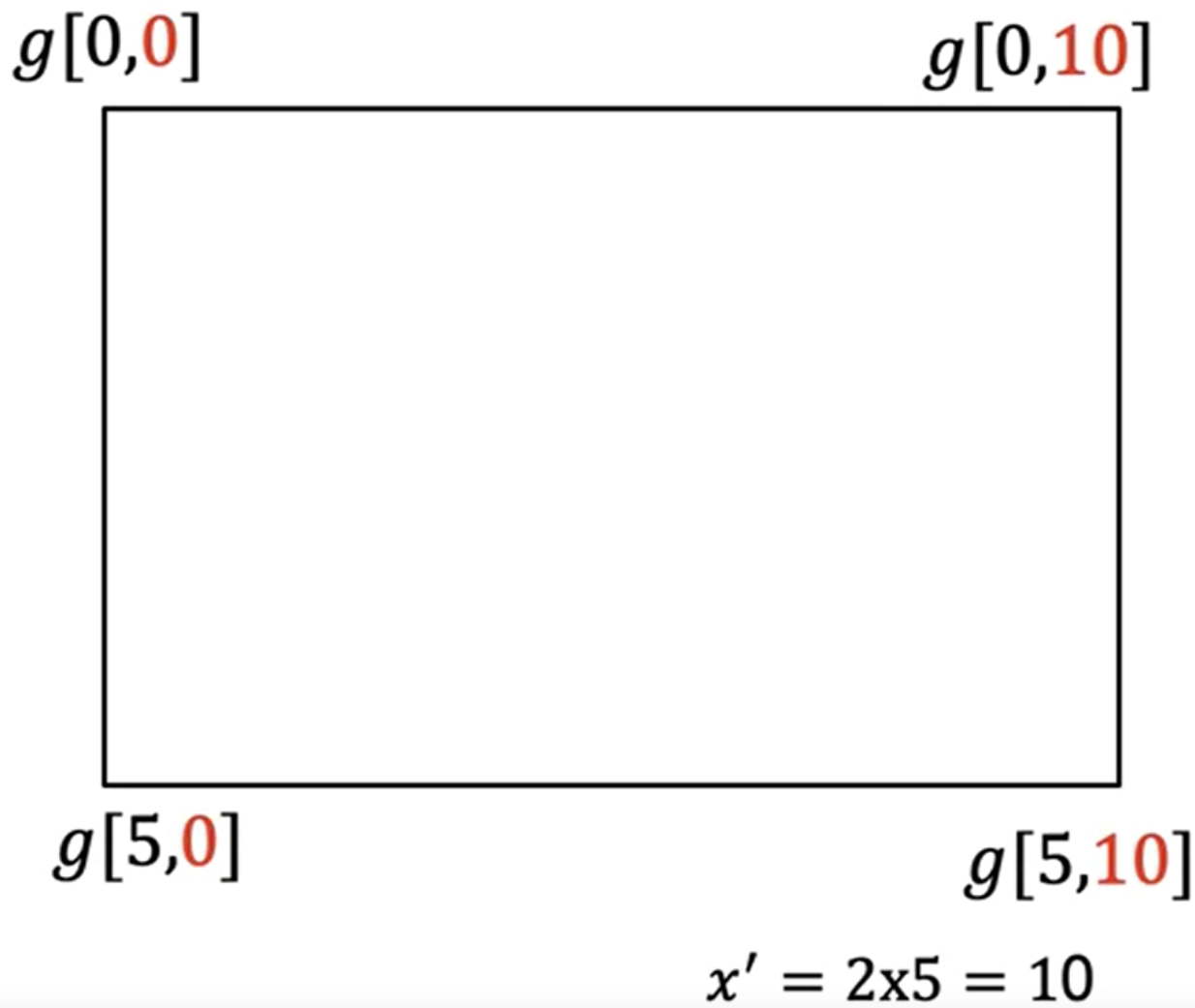
$x' = 2x5 = 10$

$f[0,0]$ $f[0,5]$ $g[0,0]$ $g[0,10]$



$x' = ax$ $x' = 2x$





$x' = 2x5 = 10$

f[0,0]	f[0,1]	f[0,2]	f[0,3]	f[0,4]	f[0,5]
f[1,0]	f[1,2]	f[1,2]	f[1,3]	f[1,4]	f[1,5]
f[2,0]	f[2,2]	f[2,2]	f[2,3]	f[2,4]	f[2,5]
f[3,0]	f[3,1]	f[3,2]	f[3,3]	f[3,4]	f[3,5]
f[4,0]	f[4,1]	f[4,2]	f[4,3]	f[4,4]	f[4,5]
f[5,0]	f[5,1]	f[5,2]	f[5,3]	f[5,4]	f[5,5]

g[0,0]	g[0,1]	g[0,2]	g[0,3]	g[0,4]	g[0,5]	g[0,6]	g[0,7]	g[0,8]	g[0,9]	g[0,10]
g[1,0]	g[1,1]	g[1,2]	g[1,3]	g[1,4]	f[1,5]	g[1,6]	g[1,7]	g[1,8]	g[1,9]	g[1,10]
g[2,0]	g[2,1]	g[2,2]	g[2,3]	g[2,4]	g[2,5]	g[2,6]	g[2,7]	g[2,8]	g[2,9]	g[2,10]
g[3,0]	g[3,1]	g[3,2]	g[3,3]	g[3,4]	g[3,5]	g[3,6]	g[3,7]	g[3,8]	g[3,9]	g[3,10]
g[4,0]	g[4,1]	g[4,2]	g[4,3]	g[4,4]	g[4,5]	g[4,6]	g[4,7]	g[4,8]	g[4,9]	g[4,10]
g[5,0]	g[5,1]	g[5,2]	g[5,3]	g[5,4]	g[5,5]	g[5,6]	g[5,7]	g[5,8]	g[5,9]	g[5,10]

f[0,0]	f[0,1]	f[0,2]	f[0,3]	f[0,4]	f[0,5]
f[1,0]	f[1,2]	f[1,2]	f[1,3]	f[1,4]	f[1,5]
f[2,0]	f[2,2]	f[2,2]	f[2,3]	f[2,4]	f[2,5]
f[3,0]	f[3,1]	f[3,2]	f[3,3]	f[3,4]	f[3,5]
f[4,0]	f[4,1]	f[4,2]	f[4,3]	f[4,4]	f[4,5]
f[5,0]	f[5,1]	f[5,2]	f[5,3]	f[5,4]	f[5,5]

g[0,0]	g[0,1]	g[0,2]	g[0,3]	g[0,4]	g[0,5]	g[0,6]	g[0,7]	g[0,8]	g[0,9]	g[0,10]
g[1,0]	g[1,1]	g[1,2]	g[1,3]	g[1,4]	f[1,5]	g[1,6]	g[1,7]	g[1,8]	g[1,9]	g[1,10]
g[2,0]	g[2,1]	g[2,2]	g[2,3]	g[2,4]	g[2,5]	g[2,6]	g[2,7]	g[2,8]	g[2,9]	g[2,10]
g[3,0]	g[3,1]	g[3,2]	g[3,3]	g[3,4]	g[3,5]	g[3,6]	g[3,7]	g[3,8]	g[3,9]	g[3,10]
g[4,0]	g[4,1]	g[4,2]	g[4,3]	g[4,4]	g[4,5]	g[4,6]	g[4,7]	g[4,8]	g[4,9]	g[4,10]
g[5,0]	g[5,1]	g[5,2]	g[5,3]	g[5,4]	g[5,5]	g[5,6]	g[5,7]	g[5,8]	g[5,9]	g[5,10]

f[0,0]	f[0,1]	f[0,2]	f[0,3]	f[0,4]	f[0,5]
f[1,0]	f[1,2]	f[1,2]	f[1,3]	f[1,4]	f[1,5]
f[2,0]	f[2,2]	f[2,2]	f[2,3]	f[2,4]	f[2,5]
f[3,0]	f[3,1]	f[3,2]	f[3,3]	f[3,4]	f[3,5]
f[4,0]	f[4,1]	f[4,2]	f[4,3]	f[4,4]	f[4,5]
f[5,0]	f[5,1]	f[5,2]	f[5,3]	f[5,4]	f[5,5]

g[0,0]	g[0,1]	g[0,2]	g[0,3]	g[0,4]	g[0,5]	g[0,6]	g[0,7]	g[0,8]	g[0,9]	g[0,10]
g[1,0]	g[1,1]	g[1,2]	g[1,3]	g[1,4]	f[1,5]	g[1,6]	g[1,7]	g[1,8]	g[1,9]	g[1,10]
g[2,0]	g[2,1]	g[2,2]	g[2,3]	g[2,4]	g[2,5]	g[2,6]	g[2,7]	g[2,8]	g[2,9]	g[2,10]
g[3,0]	g[3,1]	g[3,2]	g[3,3]	g[3,4]	g[3,5]	g[3,6]	g[3,7]	g[3,8]	g[3,9]	g[3,10]
g[4,0]	g[4,1]	g[4,2]	g[4,3]	g[4,4]	g[4,5]	g[4,6]	g[4,7]	g[4,8]	g[4,9]	g[4,10]
g[5,0]	g[5,1]	g[5,2]	g[5,3]	g[5,4]	g[5,5]	g[5,6]	g[5,7]	g[5,8]	g[5,9]	g[5,10]

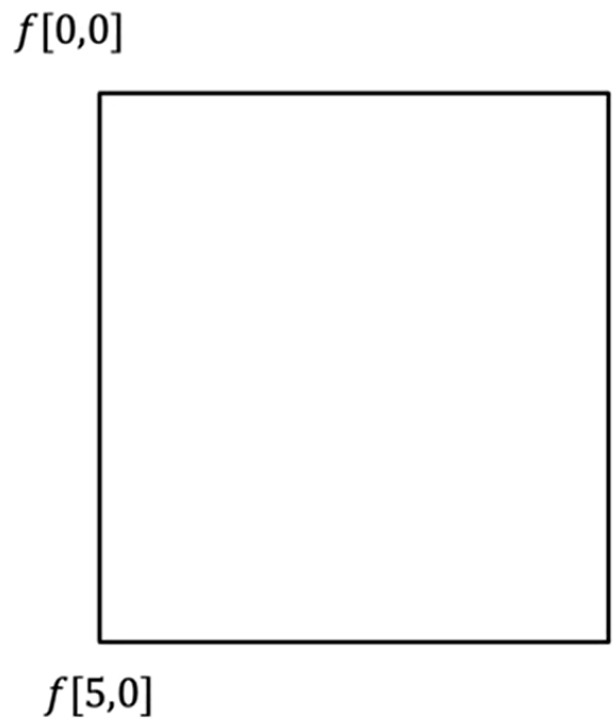
f[0,0]	f[0,1]	f[0,2]	f[0,3]	f[0,4]	f[0,5]
f[1,0]	f[1,2]	f[1,2]	f[1,3]	f[1,4]	f[1,5]
f[2,0]	f[2,2]	f[2,2]	f[2,3]	f[2,4]	f[2,5]
f[3,0]	f[3,1]	f[3,2]	f[3,3]	f[3,4]	f[3,5]
f[4,0]	f[4,1]	f[4,2]	f[4,3]	f[4,4]	f[4,5]
f[5,0]	f[5,1]	f[5,2]	f[5,3]	f[5,4]	f[5,5]

g[0,0]	g[0,0]	g[0,2]	g[0,2]	g[0,4]	g[0,4]	g[0,6]	g[0,6]	g[0,8]	g[0,8]	g[0,10]
g[1,0]	g[1,0]	g[1,2]	g[1,2]	g[1,4]	g[1,4]	g[1,6]	g[1,6]	g[1,8]	g[1,8]	g[1,10]
g[2,0]	g[2,0]	g[2,2]	g[2,2]	g[2,4]	g[2,4]	g[2,6]	g[2,6]	g[2,8]	g[2,8]	g[2,10]
g[3,0]	g[3,0]	g[3,2]	g[3,2]	g[3,4]	g[3,4]	g[3,6]	g[3,6]	g[3,8]	g[3,8]	g[3,10]
g[4,0]	g[4,0]	g[4,2]	g[4,2]	g[4,4]	g[4,4]	g[4,6]	g[4,6]	g[4,8]	g[4,8]	g[4,10]
g[5,0]	g[5,0]	g[5,2]	g[5,2]	g[5,4]	g[5,4]	g[5,6]	g[5,6]	g[5,8]	g[5,8]	g[5,10]

Translation

$$x' = x + t_x$$

$$x' = x + 2$$

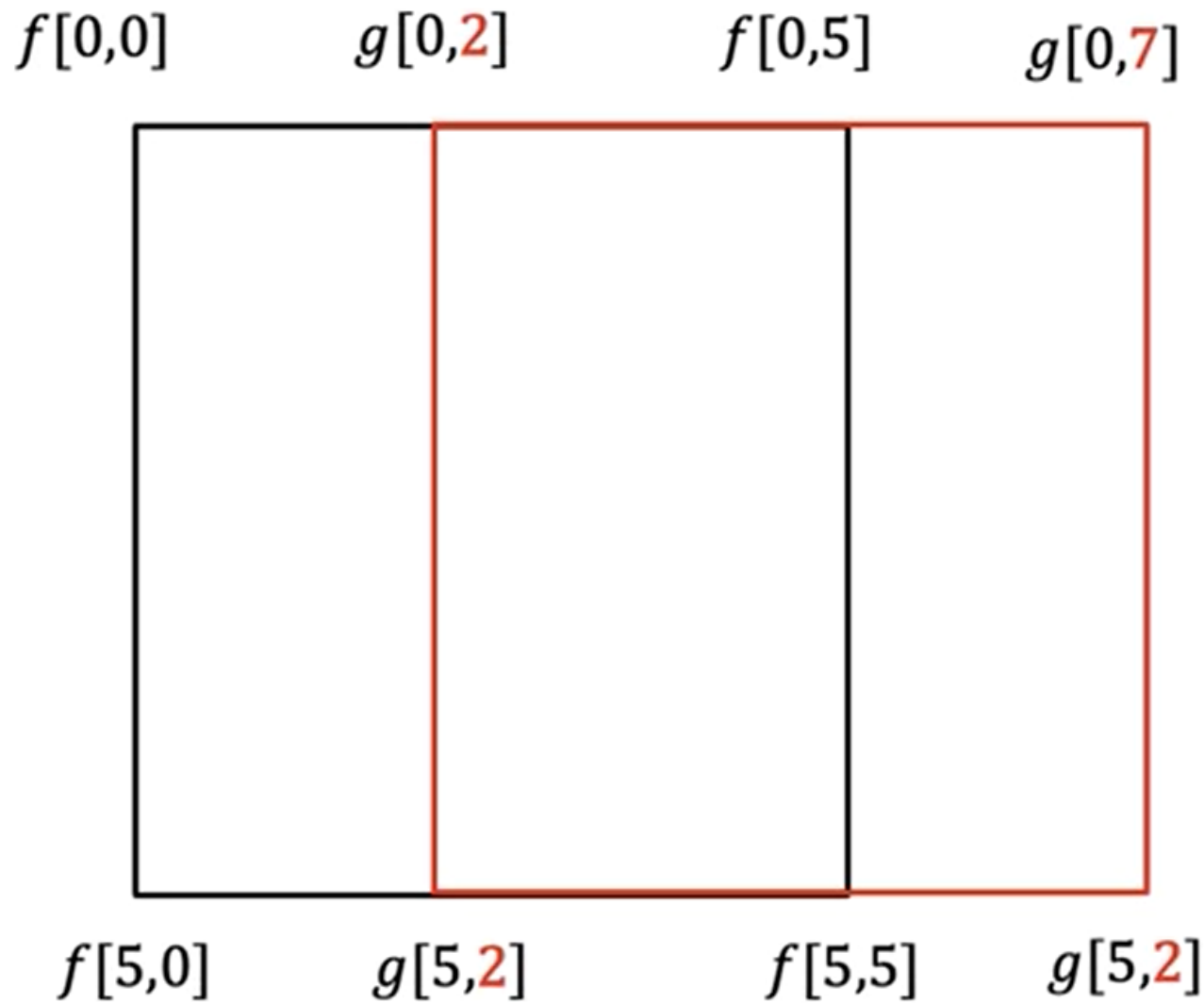


$$x' = x + t_x$$

$$x' = x + 2$$

$$x' = 0 + 2 = 2$$

$$x' = 5 + 2 = 7$$



f[0,0]	f[0,1]	f[0,2]	f[0,3]	f[0,4]	f[0,5]
f[1,0]	f[1,2]	f[1,2]	f[1,3]	f[1,4]	f[1,5]
f[2,0]	f[2,2]	f[2,2]	f[2,3]	f[2,4]	f[2,5]
f[3,0]	f[3,1]	f[3,2]	f[3,3]	f[3,4]	f[3,5]
f[4,0]	f[4,1]	f[4,2]	f[4,3]	f[4,4]	f[4,5]
f[5,0]	f[5,1]	f[5,2]	f[5,3]	f[5,4]	f[5,5]

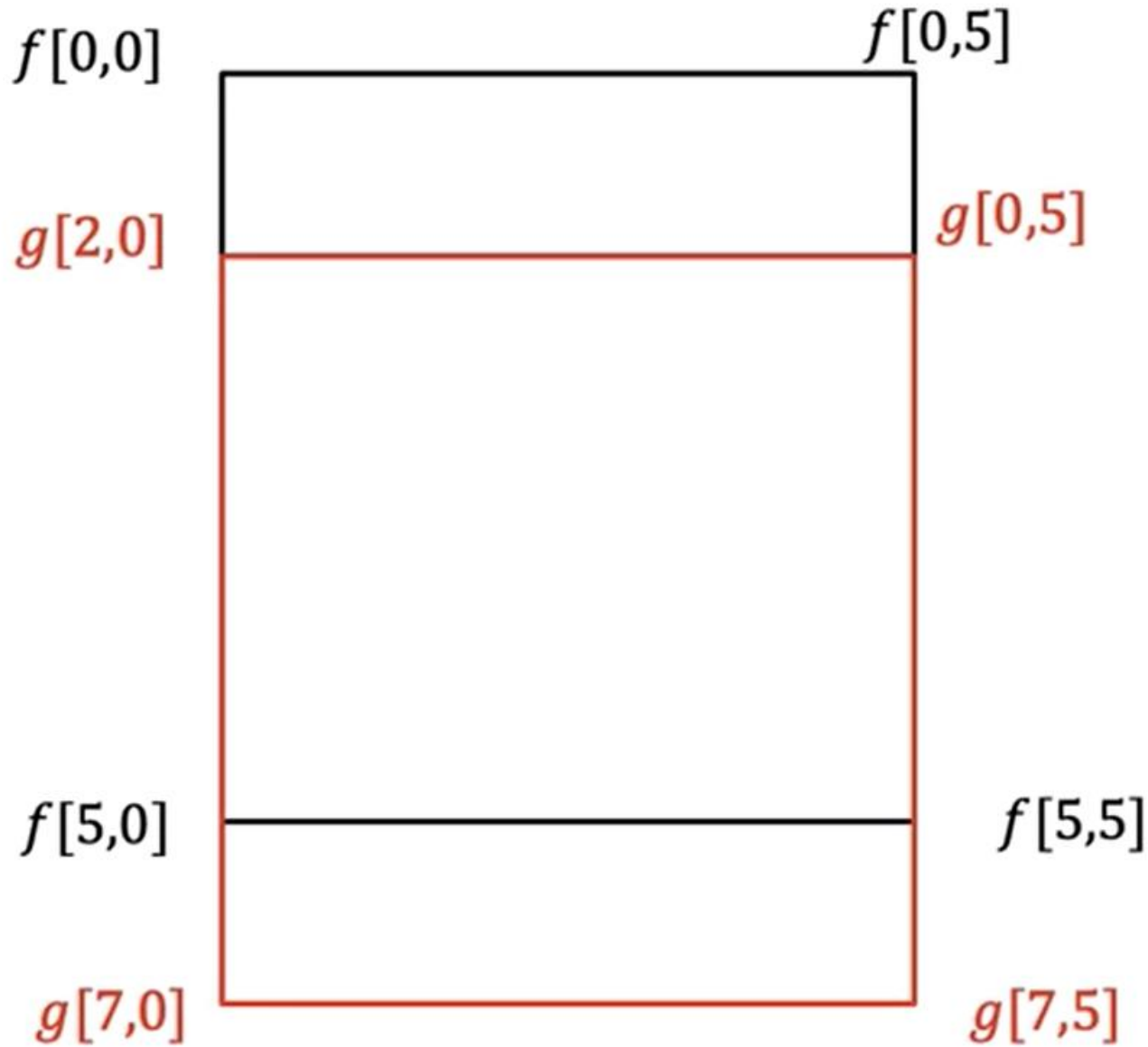
	g[0,1]	g[0,2]	g[0,3]	g[0,4]	g[0,5]
	g[1,1]	[1,2]	g[1,3]	g[1,4]	f[1,5]
	g[2,1]	f[2,2]	g[2,3]	g[2,4]	g[2,5]
	g[3,1]	f[3,2]	g[3,3]	g[3,4]	g[3,5]
	g[4,1]	f[4,2]	g[4,3]	g[4,4]	g[4,5]
	g[5,1]	f[5,2]	g[5,3]	g[5,4]	g[5,5]

$$y' = y + t_y$$

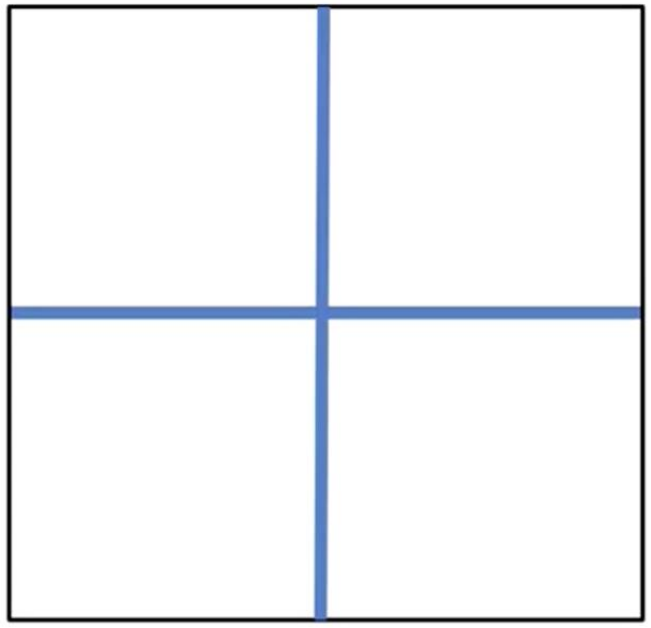
$$y' = y + 2$$

$$y' = 0 + 2 = 2$$

$$y' = 5 + 2 = 7$$

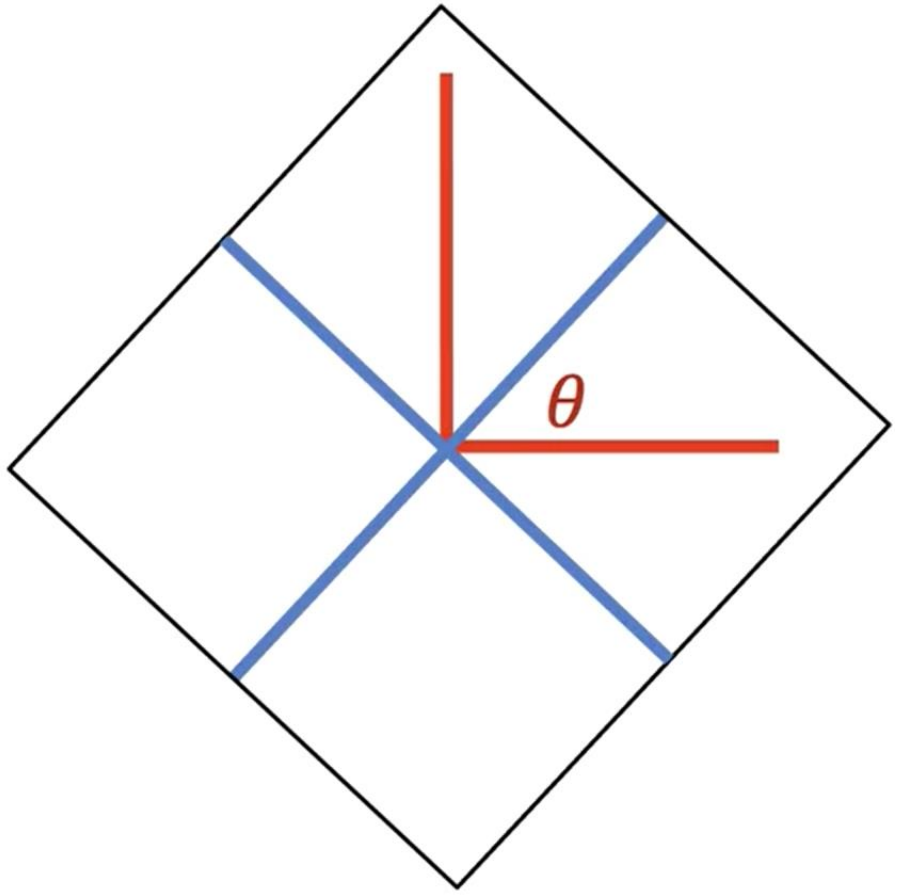


Rotation

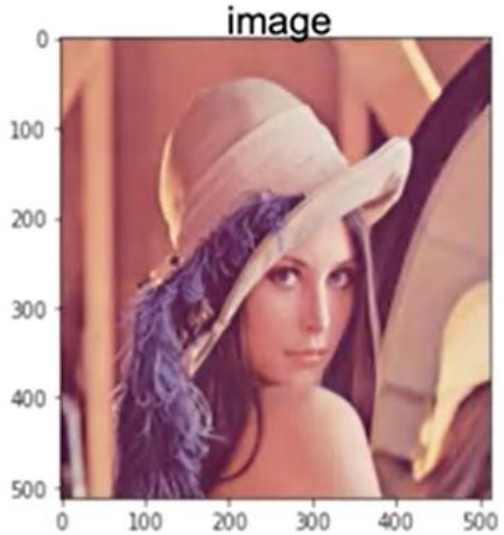


θ

Theta

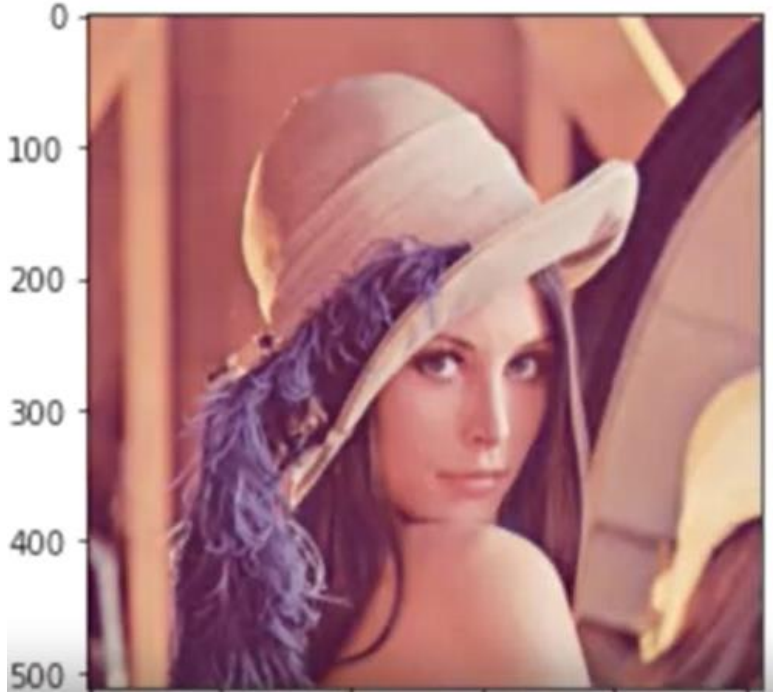


```
from PIL import Image

 image = Image.open("lenna.png")

 width= 512
 hight=512
new_width=2*width
new_hight=hight

new_image=image.resize((new_width,new_hight))
```

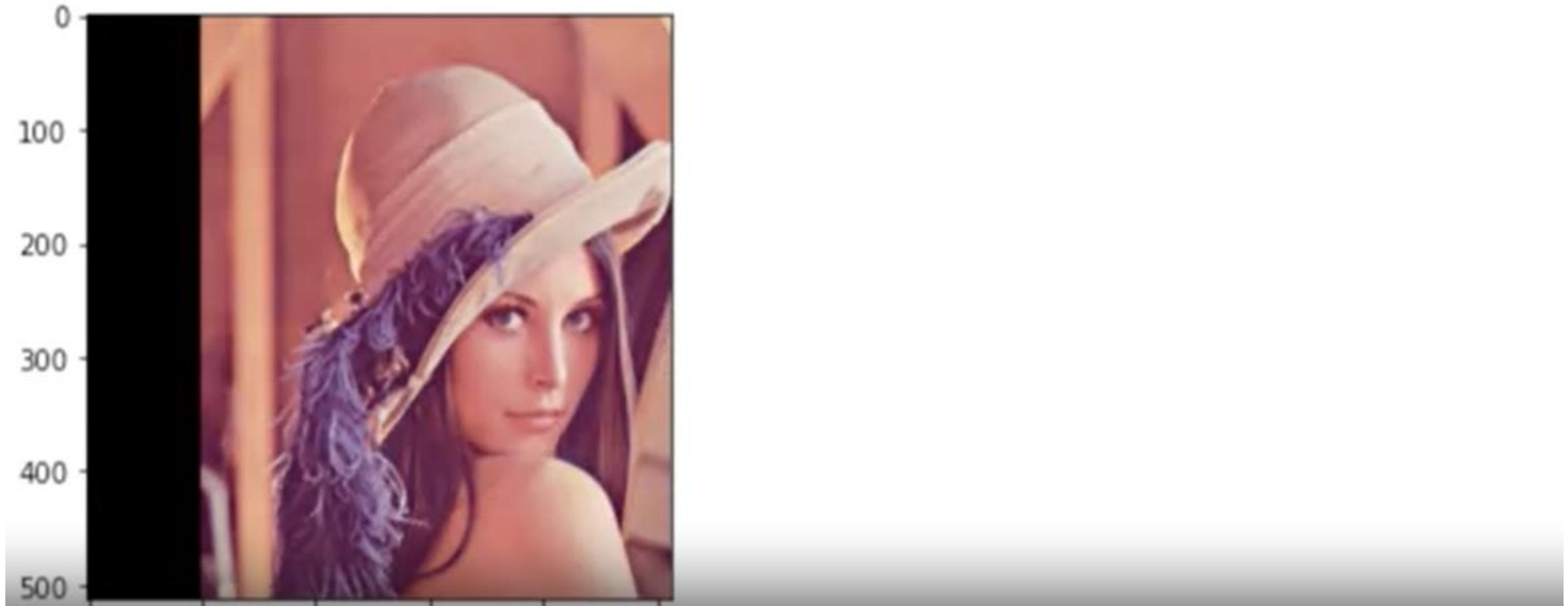


```
image = Image.open("lenna.png")

theta=45

new_image=image.rotate(theta)
```

```
import cv2

image = cv2.imread("lenna.png")


new_image= cv2.resize(image,None,fx=2, fy=1, interpolation =  cv2.INTER_CUBIC )
```



```
rows,cols,_=image.shape

tx=100
ty=0
M = np.float32([[1,0,tx],[0,1,ty]])

new_image = cv2.warpAffine(image,M,(cols,rows))
```



```
theta=45.0
M = cv2.getRotationMatrix2D(center=(cols//2-1,rows//2-1),angle=theta,scale=1)

 new_image = cv2.warpAffine(image,M,(cols,rows))
```