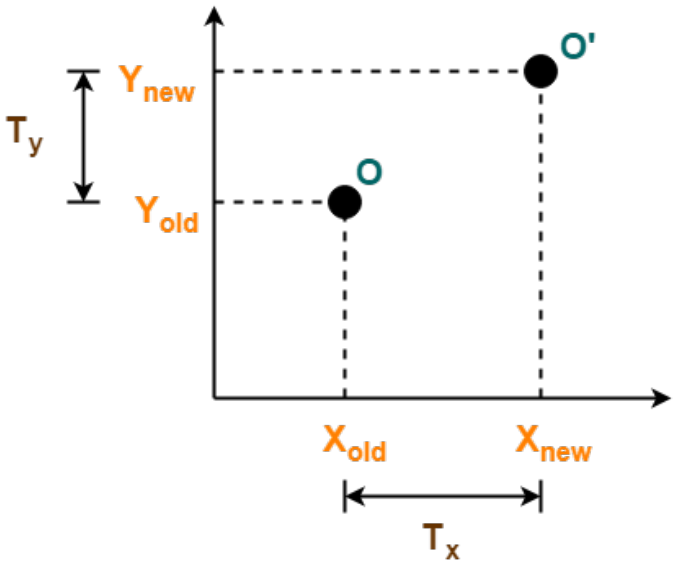
Computer Animation Lab: 05

Contents

- In this lab, we will apply the animation of the 2D transformations.
- Transoformations are the processes of re-positioning or modifying an object in a two dimensional plane.
- Transformation techniques:
    - Translation
    - Rotation
    - Scaling
    - Reflection
    - Shear
- We will apply the translation, rotation, and scaling only.

Translation

- Translation is a process of moving an object from one position to another.
- Suppose that we have a point O that we need to translate in a 2D plane.
- Let:
  - Initial coordinates of the point are $O = (X_{old}, Y_{old})$
  - X-axis translation distance is T_x, and y-axis translation is T_y
  - New coordinates of the point are $O = (X_{new}, Y_{new})$



- The translation can be represented as:

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} X_{old} \\ Y_{old} \end{bmatrix} + \begin{bmatrix} T_x \\ T_y \end{bmatrix}$$

$$X_{new} = X_{old} + T_x$$

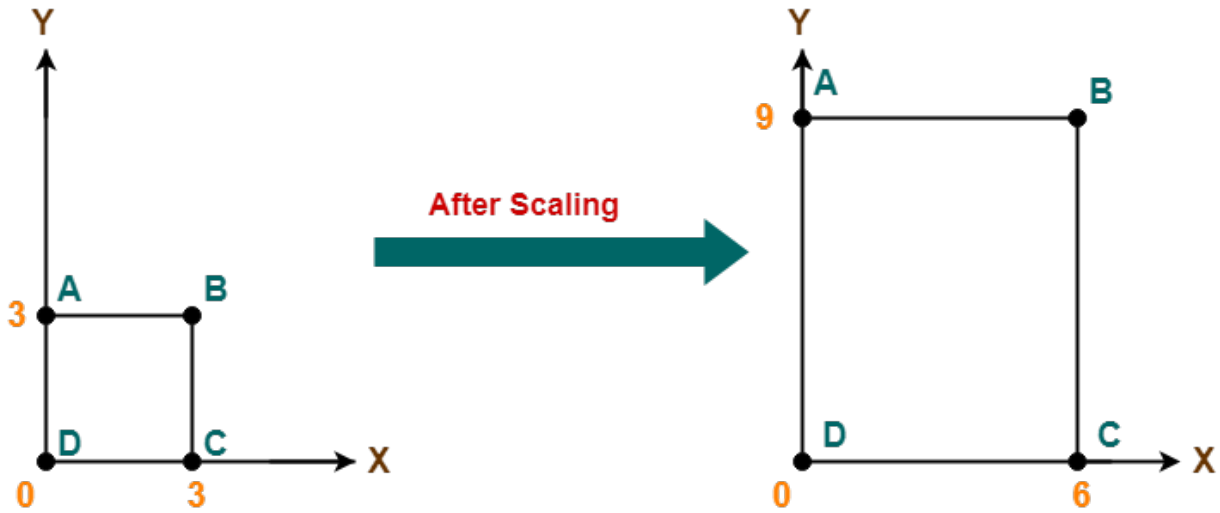
$$Y_{new} = Y_{old} + T_y$$

Code

```
from tkinter import *

def translate(cx, cy, T):
    tcx = cx + T[0]
    tcy = cy + T[1]
    return tcx, tcy

window = Tk()
cnvs = Canvas(window, width=500, height=500)
cnvs.pack()
cx = 250; cy = 250
width = 100; height = 200
x1 = cx - (width / 2)
y1 = cy - (height / 2)
x2 = cx + (width / 2)
y2 = cy - (height / 2)
x3 = cx + (width / 2)
y3 = cy + (height / 2)
x4 = cx - (width / 2)
y4 = cy + (height / 2)
cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, tags="p1")

endx = 200; endy = 80
tx = 5; ty = 5
while tx < endx and ty < endy:
    tcx, tcy = translate(cx, cy, (tx, ty))

    x1 = tcx - (width / 2)
    y1 = tcy - (height / 2)
    x2 = tcx + (width / 2)
    y2 = tcy - (height / 2)
    x3 = tcx + (width / 2)
    y3 = tcy + (height / 2)
    x4 = tcx - (width / 2)
    y4 = tcy + (height / 2)
    cnvs.delete("p1")
    cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, tags="p1")
    cnvs.after(100)
    cnvs.update()

    if tx < endx:
        tx += 5
    if ty < endy:
        ty += 5

window.mainloop()
```

Scaling

- Scaling is a process of modifying or altering the size of objects.
  - Scaling may be used to increase or reduce the size of object.
- Scaling factor determines whether the object size is to be increased or reduced.
  - If scaling factor > 1, then the object size is increased.
  - If scaling factor < 1, then the object size is reduced.



- Let-
  - Initial coordinates of the object $O = (X_{old}, Y_{old})$
  - Scaling factor for X-axis = S_x
  - Scaling factor for Y-axis = S_y
  - New coordinates of the object O after scaling = (X_{new}, Y_{new})
- Scaling is achieved using the following equation

$$\begin{bmatrix} x_{new} \\ y_{new} \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \times \begin{bmatrix} x_{old} \\ y_{old} \end{bmatrix}$$

$$x_{new} = x_{old} * S_x$$

$$y_{new} = y_{old} * S_y$$

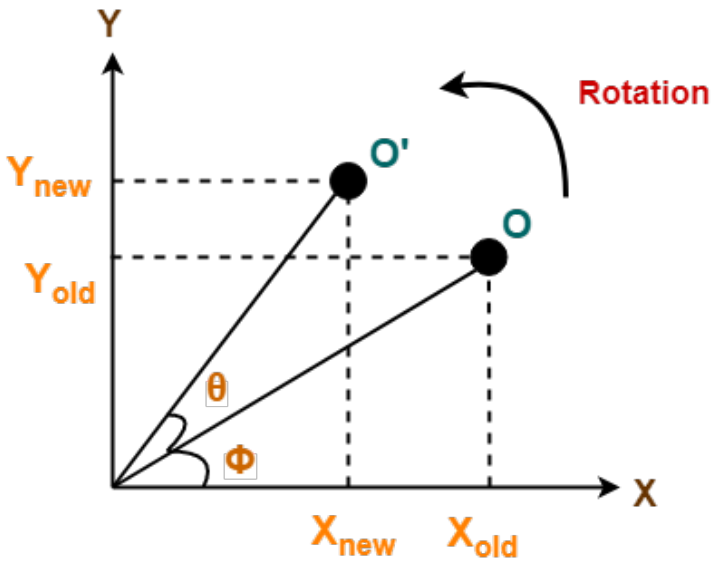
Code

```
from tkinter import *

def scale(lt, rt, rb, lb, S):
    sx1 = lt[0] * S[0]
    sy1 = lt[1] * S[1]
    sx2 = rt[0] * S[0]
    sy2 = rt[1] * S[1]
    sx3 = rb[0] * S[0]
    sy3 = rb[1] * S[1]
    sx4 = lb[0] * S[0]
    sy4 = lb[1] * S[1]
    return sx1, sy1, sx2, sy2, sx3, sy3, sx4, sy4


window = Tk()
cnvs = Canvas(window, width=500, height=500)
cnvs.pack()
cx = 250
cy = 250
width = 100
height = 200
x1 = cx - (width / 2)
y1 = cy - (height / 2)
x2 = cx + (width / 2)
y2 = cy - (height / 2)
x3 = cx + (width / 2)
y3 = cy + (height / 2)
x4 = cx - (width / 2)
y4 = cy + (height / 2)
cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, tags="p1")


endx = 1 + 3/100
endy = 1 + 3/100
sx = 1
sy = 1
```

```
while sx < endx or sy < endy:
    sx1, sy1, sx2, sy2, sx3, sy3, sx4, sy4 = scale((x1, y1), (x2, y2),
(x3, y3), (x4, y4), (sx, sy))

    width = abs(sx1 - sx2)
    height = abs(sy1 - sy4)
    x1 = cx - (width / 2)
    y1 = cy - (height / 2)
    x2 = cx + (width / 2)
    y2 = cy - (height / 2)
    x3 = cx + (width / 2)
    y3 = cy + (height / 2)
    x4 = cx - (width / 2)
    y4 = cy + (height / 2)
    cnvs.delete("p1")
    cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, tags="p1")
    cnvs.after(100)
    cnvs.update()

    if sx < endx:
        sx += 0.001
    if sy < endy:
        sy += 0.001

    print(sx, sy)
window.mainloop()
```

Rotation

- 2D Rotation is a process of rotating an object with respect to an angle in a two-dimensional plane.
- Let-
  - Initial coordinates of the object $O = (X_{old}, Y_{old})$
  - Rotation angle = θ
  - New coordinates of the object O after rotation = (X_{new}, Y_{new})



- This rotation is achieved by using the following rotation equations

$$\begin{bmatrix} x_{new} \\ y_{new} \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \times \begin{bmatrix} x_{old} \\ y_{old} \end{bmatrix}$$

$$x_{new} = x_{old} * \cos(\theta) - y_{old} * \sin(\theta)$$

$$y_{new} = x_{old} * \sin(\theta) + y_{old} * \cos(\theta)$$

Code

```
from tkinter import *
from math import *


def rotate(cx, cy, top_left, top_right, bottom_right, bottom_left, theta):
    angle = radians(theta)

    x1 = top_left[0] - cx
    y1 = top_left[1] - cy

    x2 = top_right[0] - cx
    y2 = top_right[1] - cy

    x3 = bottom_right[0] - cx
    y3 = bottom_right[1] - cy

    x4 = bottom_left[0] - cx
    y4 = bottom_left[1] - cy

    rx1 = cx + (x1 * cos(angle)) - (y1 * sin(angle))
    ry1 = cy + (x1 * sin(angle)) + (y1 * cos(angle))

    rx2 = cx + (x2 * cos(angle)) - (y2 * sin(angle))
    ry2 = cy + (x2 * sin(angle)) + (y2 * cos(angle))

    rx3 = cx + (x3 * cos(angle)) - (y3 * sin(angle))
    ry3 = cy + (x3 * sin(angle)) + (y3 * cos(angle))

    rx4 = cx + (x4 * cos(angle)) - (y4 * sin(angle))
    ry4 = cy + (x4 * sin(angle)) + (y4 * cos(angle))

    return [rx1, ry1, rx2, ry2, rx3, ry3, rx4, ry4]
```

```
window = Tk()
cnvs = Canvas(window, width=500, height=500)
cnvs.pack()

cx = 250
cy = 250

width = 100
height = 150

x1 = cx - width / 2
y1 = cy - height / 2

x2 = cx + width / 2
y2 = cy - height / 2

x3 = cx + width / 2
y3 = cy + height / 2

x4 = cx - width / 2
y4 = cy + height / 2

cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, fill="green", tags="p")

theta = -5

while True:
    x1, y1, x2, y2, x3, y3, x4, y4 = rotate(cx, cy, (x1, y1), (x2, y2), (x3, y3),
                                            (x4, y4), theta)

    cnvs.delete("p")

    cnvs.create_polygon(x1, y1, x2, y2, x3, y3, x4, y4, fill="green", tags="p")

    cnvs.after(100)
    cnvs.update()

window.mainloop()
```