**2D - Transformation**

Moving the object from one position to another

* Translation - tx (translation parameter w.r.t x), ty (translation parameter w.r.t y),
* Scaling – sx, sy (resize of an object, sx- scaling parameter w.r.t. x), sy- scaling parameter w.r.t. y), - max or min
* Rotation –(rotation of an object) theta – clockwise or anticlockwise

**Translation** (Changing the position of an object)

P(x,y) - point before translation

P’(x’,y’) – point after translation

Parameters – tx, ty

X’ = x+tx

Y’ = y+ty

P’ = P+ T

(or)

**Scaling** (resize the object) – sx & sy

Conditions:

If sx and sy are in between 0 and 1 then point is closed to origin i.e., the size of the object will decrease

sx & sy >1 , away from the origin i.e., size increases

if sx & sy are equal

scaling will be done uniformly

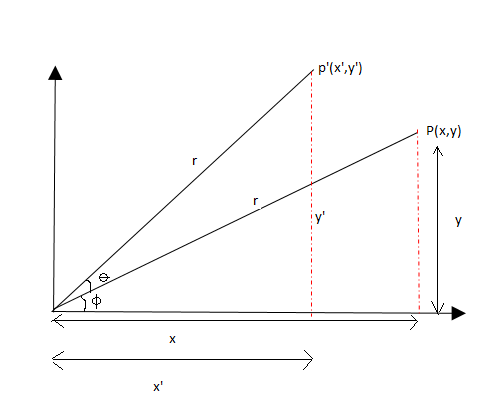
p(x,y) - before scaling

p’ (x’,y’) - after scaling

x’ = x\*sx

y’ = y\*sy

**Rotation** (rotate an object with certain angle – Anti clockwise)



cosɸ = x / r (Adjacent / Hypotenuse)

x = r cosɸ

sinɸ = y / r (Opposite / Hypotenuse)

y = r sinɸ

New angle after rotation p to p’

cos(ɸ+ɵ) = x’/r

x’ = r Cos(ɸ+ɵ)

sin(ɸ+ɵ) = y’/ r

y’ = rsin(ɸ+ɵ)

Formula

COS(A+B) = COSA COSB – SINA SINB

SIN(A+B) = SINA COSB + COSA SINB

X’ = rCOS ɸCOS ɵ - rSINɸ SIN ɵ

X’ = XCOS ɵ - Y SIN ɵ

Y’ = rsinɸ cos ɵ + rcosɸ sinɵ

x = r cosɸ

y = r sinɸ

X’ = XCOS ɵ - Y SIN ɵ

y’ = x sin ɵ + y cosɵ

**Clockwise: (ɸ-ɵ) (Practice - Homework)**

Formula

COS(A-B) = COSA COSB + SINA SINB

SIN(A-B) = SINA COSB - COSA SINB

Shearing (skewing)

x-shear

y’ = y

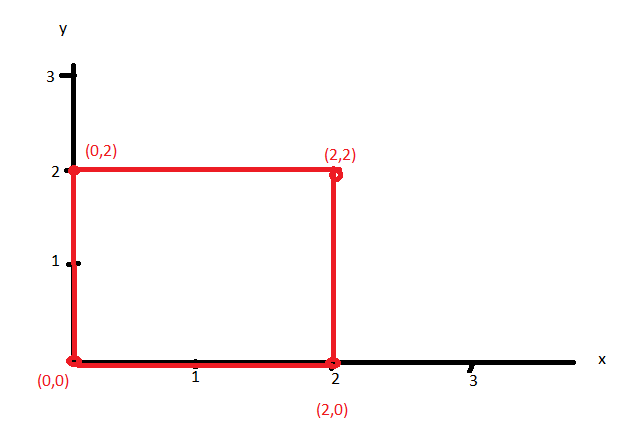
x’ = x+ shx(y)

y-shear

x’ = x

y’ = y + shy(x)

eg: let us consider a square (0,0), (0,2), (2,0), (2,2)



x-shear

shx = 2 units

for the first coordinate (0,0)

y’ = y

x’ = x+ shx \*y

y’ = 0

x’ = 0 + 2(0) = 0

(x’,y’) = (0,0)

Second coordinate (0,2)

Y’ = 2

X’ = x + shx \*y

= 0 + 2(2) = 4

(x’,y’) = (4,2)

Third coordinate (2,0)

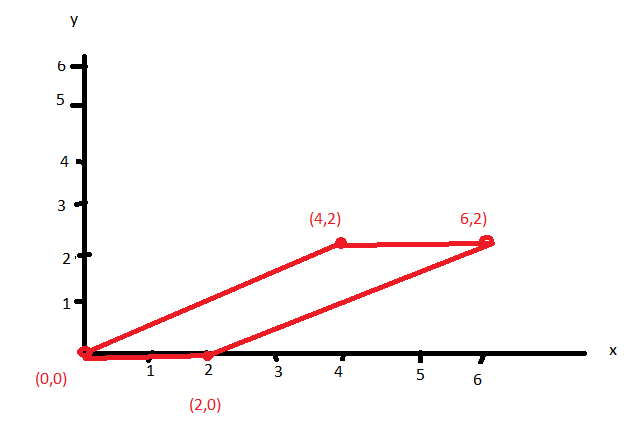
Y’ = 0

X’ = 2+2(0) = 2

(2,0)

Fourth coordinate (2,2)

(x’, y’ ) = (6,2)



Now y shear

Y shear = 2 units

(homework)

Solution

(0,0) 🡪 (0,0)

(0,2) 🡪 (0,2)

(2,0) 🡪 (2,4)

(2,2) 🡪 (2,6)

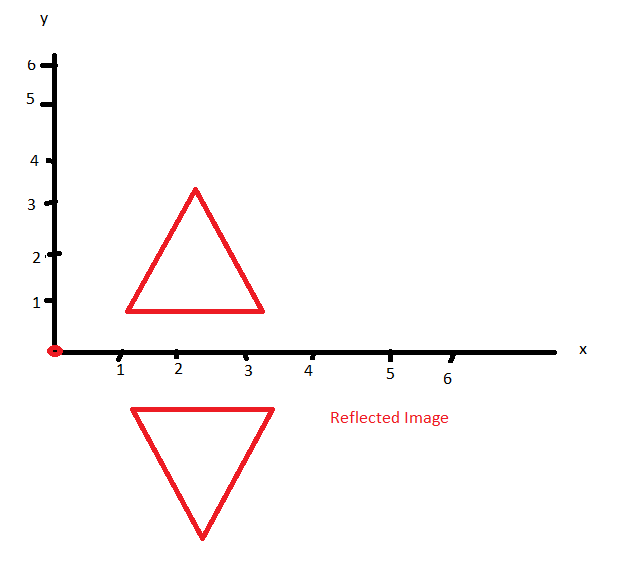
Matrix representation (homogeneous)

x-shear

y-shear

Reflection ( Mirror or 180 degree)

x-axis



Example: the coordinates are (2,2), (4,2), (3,4)

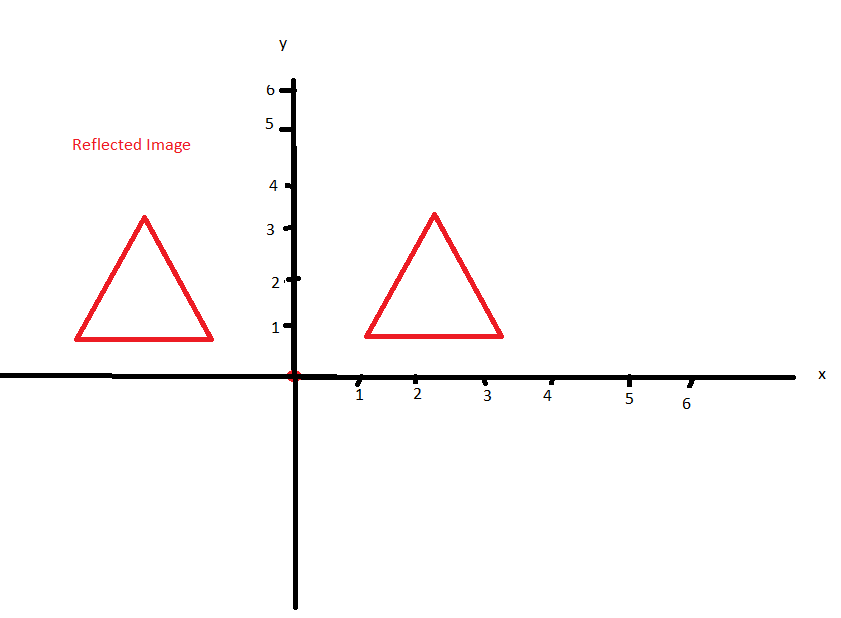
For the first coordinate (2,2,1)

= = (2,-2)

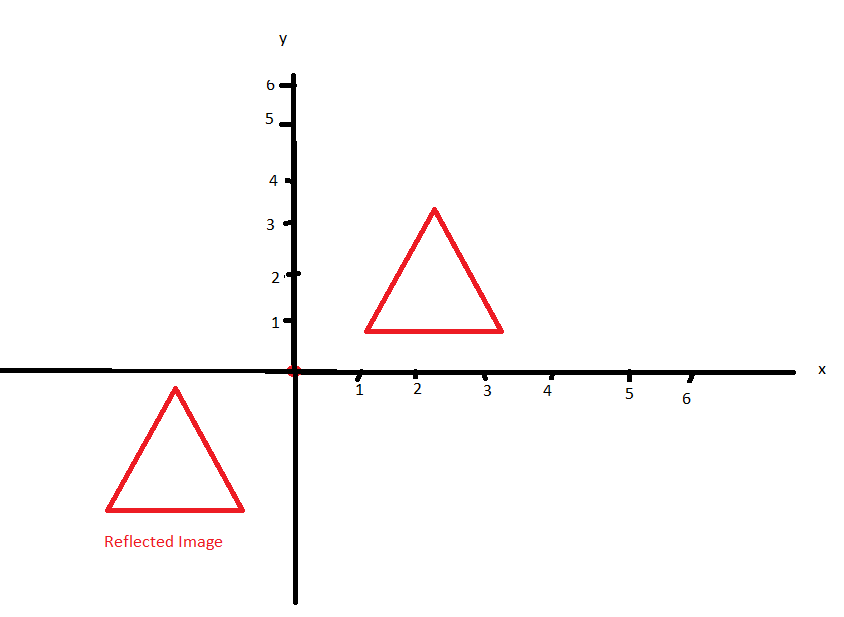
Second coordinate (4,2) 🡪 (4,-2)

Third coordinate (3,4) 🡪 (3,-4)

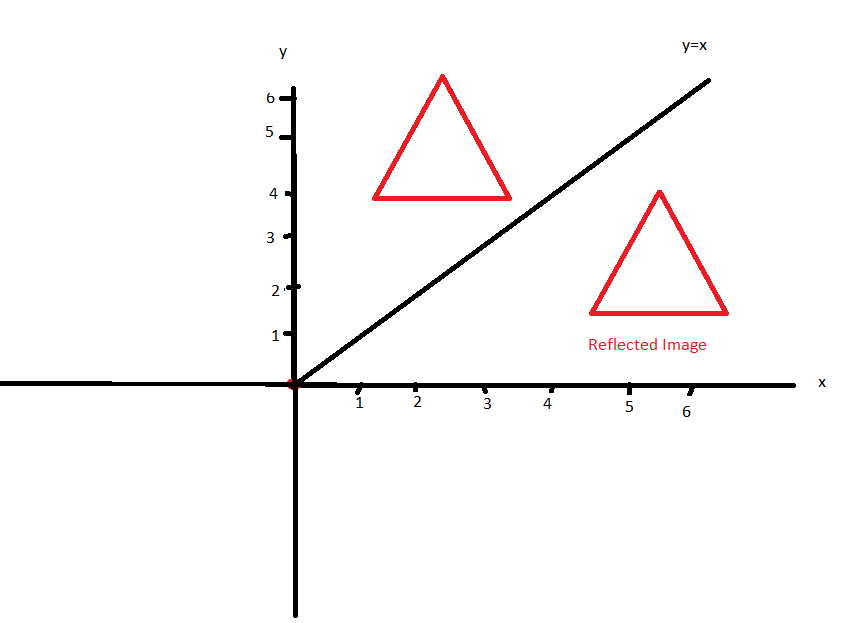
y-axis



Reflection towards origin



Reflection y = x



**3D Transformation**

**3D - Translation** (Changing the position of an object)

P(x,y,z) - point before translation

P’(x’,y’, z’) – point after translation

Parameters – tx, ty, tz

X’ = x+tx

Y’ = y+ty

Z’ = z+tz

**3D- Scaling**

**Scaling** (resize the object) – sx ,sy & sz

Conditions:

If sx and sy are in between 0 and 1 then point is closed to origin i.e., the size of the object will decrease

sx & sy >1 , away from the origin i.e., size increases

if sx & sy are equal

scaling will be done uniformly

p(x,y,z) - before scaling

p’ (x’,y’,z’ ) - after scaling

x’ = x\*sx

y’ = y\*sy

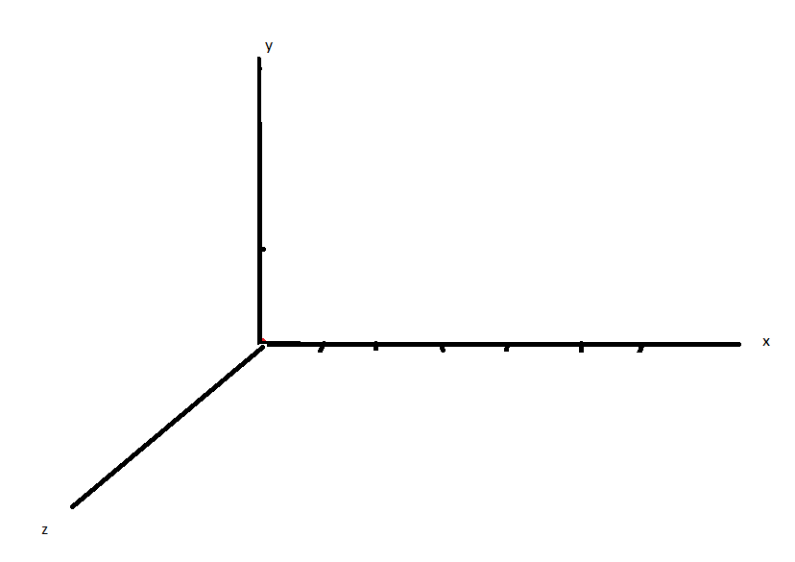
z’ =z\*sz

Rotation:

xRoll – Rotation w.r.t.x

yroll – rotation w.r.t.y

zroll – rotation w.r.t.z

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**z-Roll**

z’ = z

X’ = XCOS ɵ - Y SIN ɵ

y’ = x sin ɵ + y cosɵ

**x-Roll**

x’ = x

y’ = yCOS ɵ - z SIN ɵ

z’ = y sin ɵ + z cosɵ

**y-Roll**

y’ = y

z’ = zCOS ɵ - x SIN ɵ

x’ = z sin ɵ + x cosɵ

For clockwise in the matrix in the place of theta substitute -theta

3D – Reflection

Xy- plane

yz- plane

xz- plane

3D – Searing

Z shear (shx, shy)

Z’ =z

X’ = x+ z\* shx

Y’ = y + z\*shy

xshear (shx, shy)

x’ =x

y’ = y+ x\* shy

z’ = z + x\*shz

yshear (shx, shz)

y’ =y

x’ = x+ y\* shx

z’ = z + y\*shz