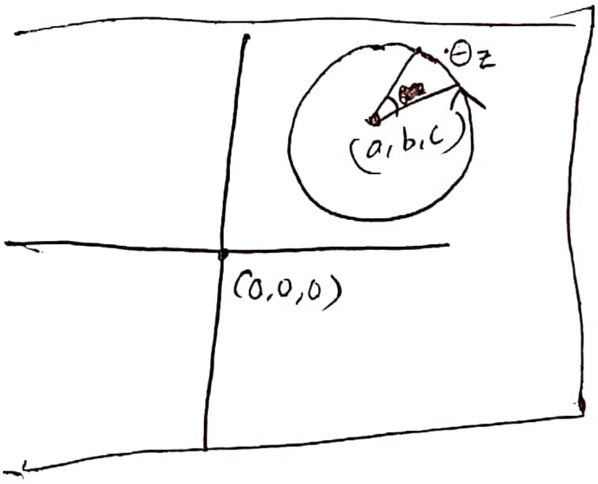
8 ~~Rev~~ Polygon filling ① Edge table
② Active edge table

9 polygon clipping ① 4 rules of cohensutherland
② clip one boundary & show output (co-ordinate)

Graphics

Co-ordinate Transformation/Modeling Transformation



$$\boxed{\begin{aligned} x_1 &= x-a \\ y_1 &= y-b \\ z_1 &= z-C \end{aligned}} \quad (1)$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \underbrace{\begin{bmatrix} 1 & 0 & 0 & a \\ 0 & 1 & 0 & b \\ 0 & 0 & 1 & c \\ 0 & 0 & 0 & 1 \end{bmatrix}}_{3} \cdot \underbrace{\begin{bmatrix} \cos\theta_z & -\sin\theta_z & 0 & 0 \\ \sin\theta_z & \cos\theta_z & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}_{2} \cdot \underbrace{\begin{bmatrix} 1 & 0 & 0 & -a \\ 0 & 1 & 0 & -b \\ 0 & 0 & 1 & -c \\ 0 & 0 & 0 & 1 \end{bmatrix}}_{1} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$
\begin{aligned}
x_2 &= (x-a)\cos\theta_z - (y-b)\sin\theta_z \\
y_2 &= (x-a)\sin\theta_z + (y-b)\cos\theta_z \\
z_2 &= z - c
\end{aligned}
\tag{2}
$$

$$
\begin{aligned}
x' &= (x-a)\cos\theta_z - (y-b)\sin\theta_z + a \\
y' &= \cancel{y}(x-a)\sin\theta_z + (y-b)\cos\theta_z + b \\
z' &= z - c + c
\end{aligned}
\tag{3}
$$

$$
\begin{aligned}
x' &= x\cos\theta_z - y\sin\theta_z + a(1-\cos\theta_z) + b\sin\theta_z \\
y' &= x\sin\theta_z - y\cos\theta_z + b(1-\cos\theta_z) - a\sin\theta_z \\
z' &= z
\end{aligned}
$$

$$
\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix}
=
\begin{bmatrix}
\cos\theta_z & -\sin\theta_z & 0 & a(1-\cos\theta_z)+b\sin\theta_z \\
\sin\theta_z & \cos\theta_z & 0 & b(1-\cos\theta_z)-a\sin\theta_z \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\cdot
\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}
$$

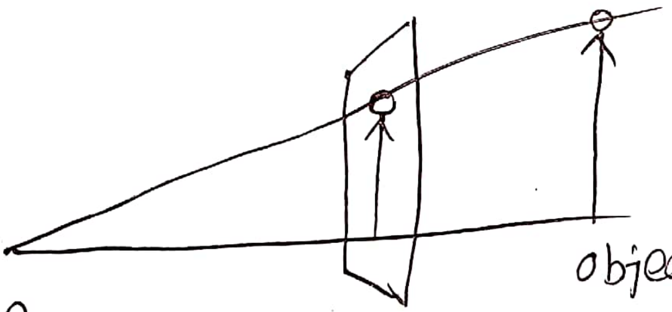
→ multiplcation → could require 5 matrix if θ_x & θ_y also changed. Order of multiplication will be → The rotation that occurs first will be on the right.

Quiz → $\theta_x / \theta_y / \theta_z$ $f(x, y, z)$ will be given find (x', y', z')

For $\theta_y \rightarrow y' = y$, x & z will change

$\theta_x \rightarrow x' = x$, y & z will change

Viewing in 3D / Projection



cop → center of projection / view point

pp → projection plane → same as view port / graphics window

object / 3D Data / model

usually center is taken as COP / COP Plane.

3 centers, they must be integrated. So →

Projection scale unit depends on object. If object is in mm/km projection scale is in mm/km.

Display depends on pixel values.

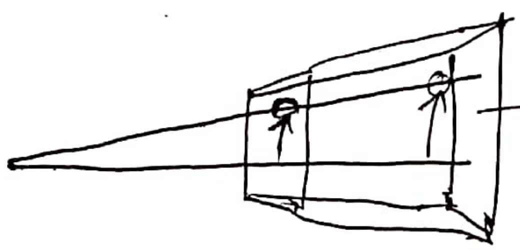
So, values are multiplied by a factor to display the things of projection plane to screen.

Original projection plane can be defined in two way: ?? (google)

① Glortho (projection plane surface)
② Glwindow (window size)

unsure

View-volume: Left, Right, Top, Bottom, Near, Far. Limit of window display.



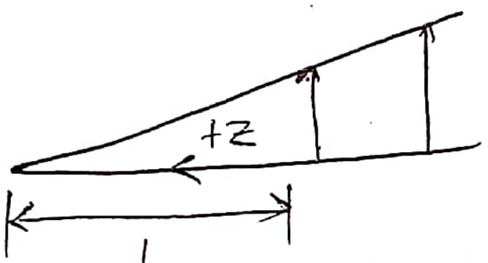
view volume

Glortho → just parallel (google)

Projection Classification (old)

Display system is 2D. 3D obj. needs to projected to this 2D screen so that the shape is recognized, by adjusting colors & shades.

$$\boxed{\text{OpenGL} \rightarrow \text{viewangle} \times \text{Distance}}$$



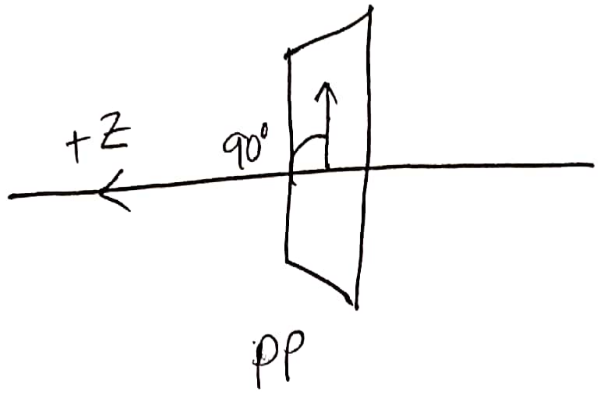
d ↳ Distance between COP & PP

⊛ Based on 'd'

① Parallel projection: 'd' infinite

② Perspective projection: 'd' finite

Nothing is truly parallel. Technically everything is perspective projection. Absolute infinity doesn't exist. Infinity is relative.



✗ Based on the orientation of PP:

1. Orthographic Projection: ~~po~~ PP is perfectly perpendicular to z-axis.
2. Oblique projection: Not perpendicular to z-axis.

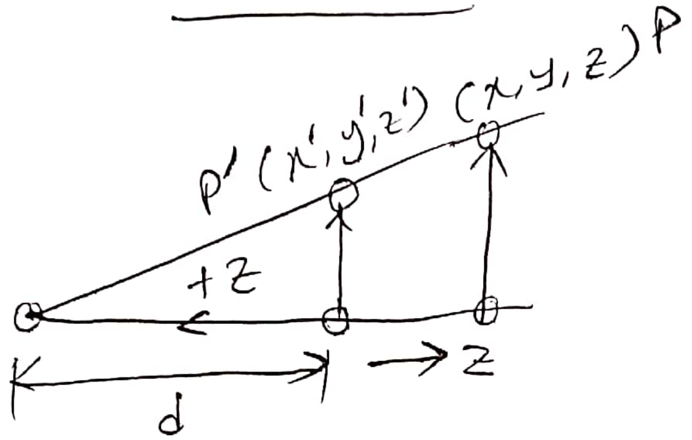
---

perspective ⟶ perspective & orthographic
orthographic ⟶ parallel & orthographic
oblique ⟶ parallel & oblique

↑ terms used these days.
There's no parallel separately

Derivation of Simple Projection Matrix ⟶

Derivation of Simple Projection Matrix



Let,
P is projected on P′ and ~~be~~ 'd' is given.

Distance → vector. ?? Displacement.

d → displacement from ~~COP to~~ PP to COP

d (+ve) → bc along z

z → displacement from O to that point in z axis.

z (−ve) → bc not along z.

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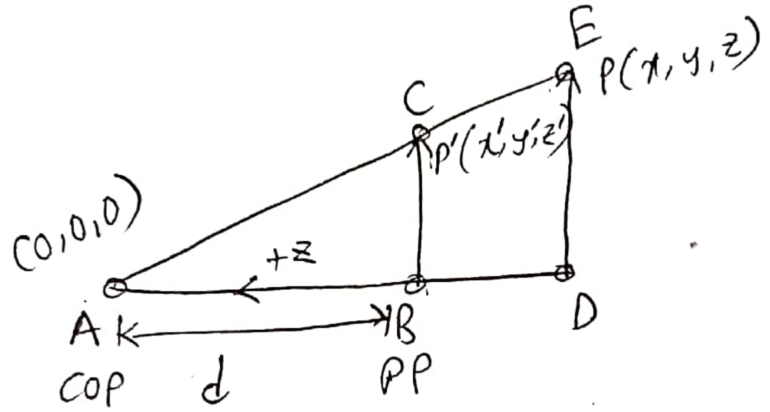
Graphics

Derivation of Simple Projection Matrices



$DE = y$

$BC = y'$

origin A, $AD = -z$

$AB = -z'$

origin B, $BD = -z$

~~ABs~~

$BD = -200$

$AB = 300$

$\frac{BC}{BA} = \frac{DE}{AD}$ — (1) [$\triangle ABC$ & $\triangle ADE$ similar]

(1) Origin of COP :

$A(0,0,0)$ $B(0,0,-d)$

~~BA AB = d~~ ~~Displacement from projection with respect to projection plane~~

~~AD = -z~~

~~BA = d~~

d is the distance from projection plane to COP.

$BA = d$

$AD = -z$

Now,

$$\frac{BC}{BA} = \frac{DE}{AD}$$

$$\Rightarrow \frac{y'}{d} = \frac{y}{-z} \quad \text{—— (ii)}$$

$$\Rightarrow y' = \frac{y}{-z/d} \quad \text{—— (iii)}$$

$$\frac{x'}{d} = \frac{x}{-z}$$

$$\Rightarrow x' = \frac{x}{-z/d}$$

$$z' = \frac{z}{-z/d}$$ [similarly]

$$\cancel{z' = \frac{z}{z}}$$

$$\Rightarrow z' = -d$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -1/d & 0 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$(x, y, z, -z/d) \rightarrow$$

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② Origin on the PP :

$A(0,0,d)$ $B(0,0,0)$ $D(0,0,-z)$

$BD = -z$
$AB = d$
$AD = d - z$

Now,

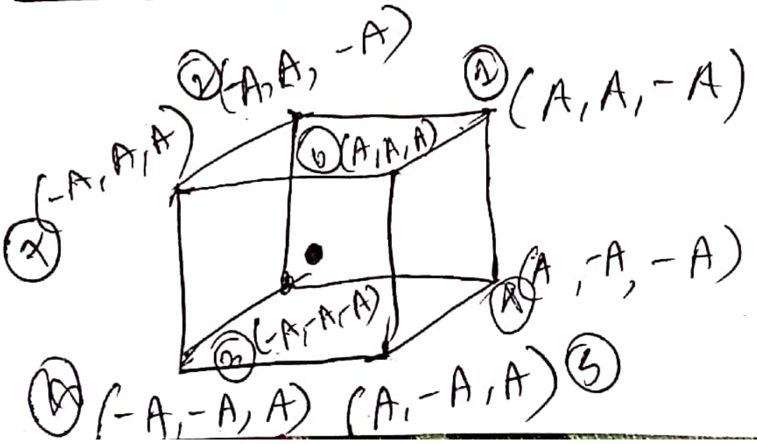
$$\frac{y'}{d} = \frac{y}{d-z} \Rightarrow y' = \frac{y}{1 - z/d}$$

$$x' = \frac{x}{1 - z/d}$$

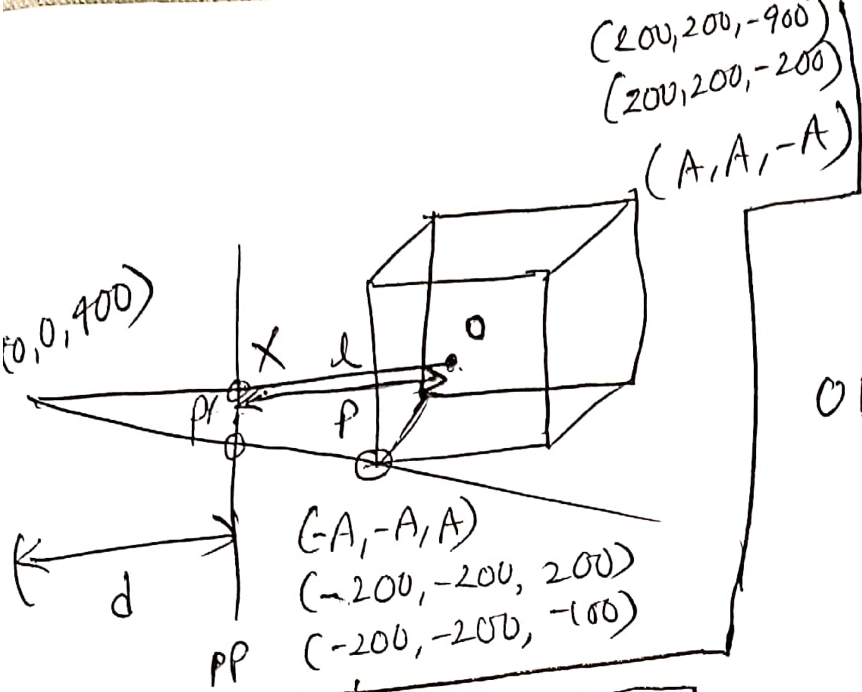
$$\cancel{z' = \frac{z}{1 - z/d}}$$

$$z' = 0$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -1/d & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$



$\boxed{\begin{array}{l} P2D[8] \rightarrow x' \,\&\, y' \quad z \text{ const} \\ P3D[8] \rightarrow x' \,\&\, y' \,\&\, z' \end{array}}$



Let, A=200

Object origin to PP=300
(O)

d=400

changing the origin from O to COP
(z value - 300) for all points

if COP = (0,0,0) X = (0, 0, -400) | then all points (zval - 300) | (-200,-200, -500)

Now, origin at COP,

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -1/400 & 0 \end{bmatrix} \begin{bmatrix} -200 \\ -200 \\ -500 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -200 \\ -200 \\ -500 \\ 500/400 \end{bmatrix} = \begin{bmatrix} -200 \\ -200 \\ -500 \\ 5/4 \end{bmatrix}$$

(-200, -200, -500)

$\Rightarrow \left(\frac{-200}{5/4}, \frac{-200}{5/4}, \frac{-500}{5/4}\right)$

$\Rightarrow (-160, -160, -400)$

Now, for topmost point,

$$\begin{bmatrix}x'\\y'\\z'\end{bmatrix} = \begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&-1/400&0\end{bmatrix}\cdot\begin{bmatrix}-200\\-200\\-900\\1\end{bmatrix}$$

$$= \begin{bmatrix}-200\\-200\\-900\\9/4\end{bmatrix}$$

LAB

---

12 lines

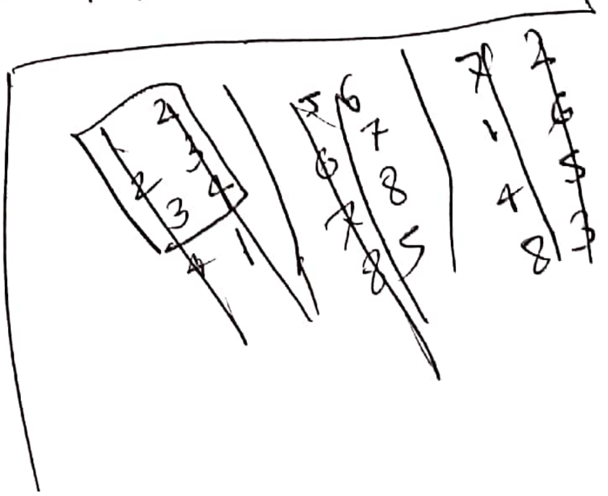
1/ P3D → P2D array

2/ use drawline to draw 12 lines

3/ Makecube(A) → make P3D
make P2D
create 12 lines

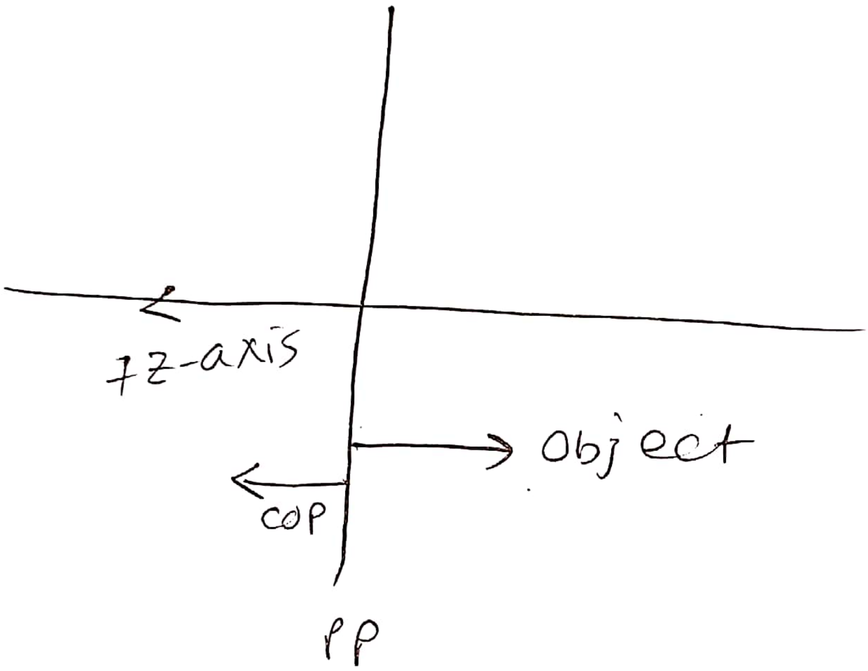
z → never 0 (if 0 error হবে)

l → object center to PP distance



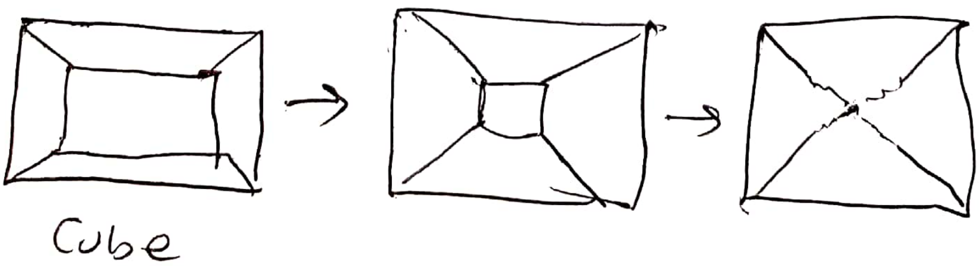
Graphics

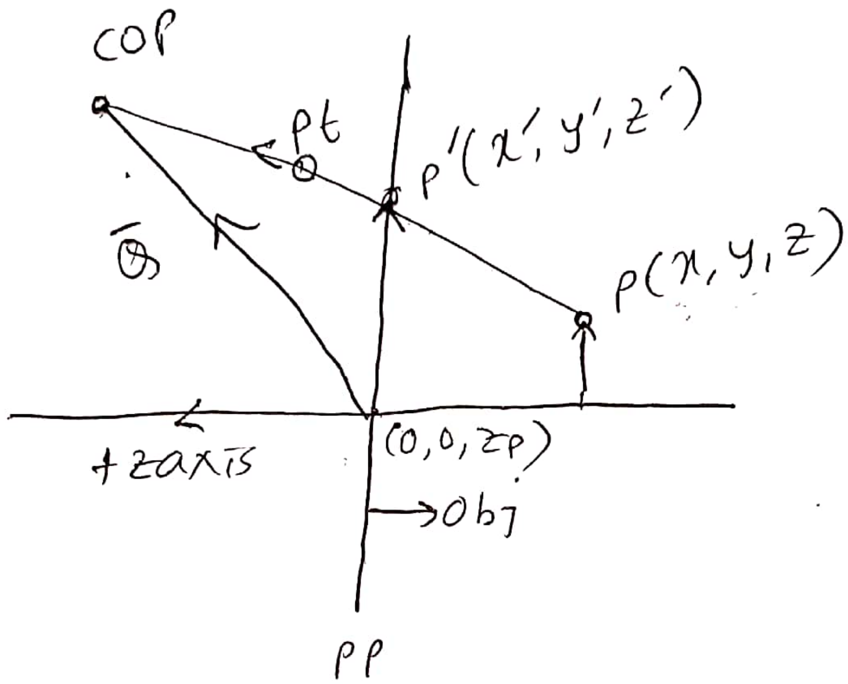
General purpose Projection Matrix



If COP in z-axis → single vanishing point

single vanishing point





$\bar{Q} = d$ if $\bar{Q}$ is along the z-axis

$COP = (0, 0, z_p) + \bar{Q}$ —— ①.a

~~COP = Q.x~~

$$\left.\begin{aligned} COP.x &= Q.x \\ COP.y &= Q.y \\ COP.z &= z_p + Q.z \end{aligned}\right\} \text{①.b}$$

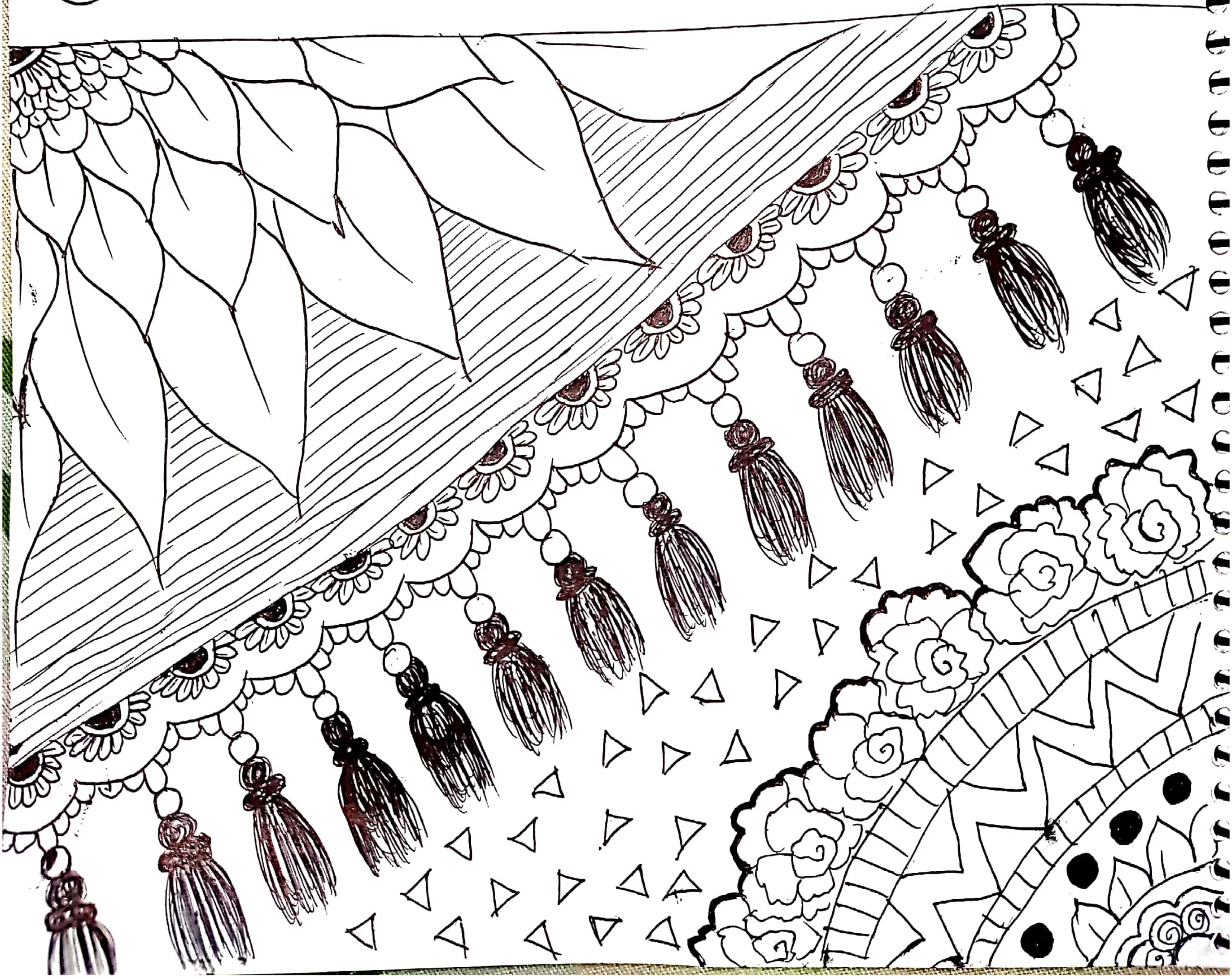
P_t is a point on the line segment COP $\xrightarrow{\text{to}}$ P

$$P_t = COP + t(P - COP) \quad \text{——} \quad (11)$$

$t = t_p$, $P_t = P'$

$$P' = COP + t_p(P - COP) \quad \text{——} \quad (11).a$$

* P & COP both are 3D points



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$$\left.\begin{aligned} x' &= Q.x + t_P(x - Q.x) \\ y' &= Q.y + t_P(y - Q.y) \\ z' &= z_P + Q.z + t_P(z - z_P - Q.z) \end{aligned}\right\} \quad \text{III}.b$$

From eq III.b,

$$z' = z_P + Q.z + t_P(z - z_P - Q_z)$$

$$\Rightarrow t_P = \frac{\cancel{z' - z_P} - Q.z}{z - z_P - Q.z} \quad \text{—— IV}$$

solving for x',

$$x' = Q.x - \frac{Q.z(x - Q.x)}{z - z_P - Q.z}$$

$$= \frac{z.Q.x - z_P.Q.x - \cancel{Q.x.Q_z} - x.Q.z + \cancel{Q.x.Q.z}}{z - z_P - Q.z}$$

$$\boxed{x' = \frac{x - z\dfrac{Q.x}{Q.z} + z_P\dfrac{Q.x}{Q.z}}{-\dfrac{z}{Q.z} + 1 + \dfrac{z_P}{Q.z}}} \quad \text{—— V}$$

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Similarly, $$\boxed{y' = \frac{y - z\frac{Q.y}{Q.z} + z_p\frac{Q.y}{Q.z}}{-\frac{z}{Q.z} + 1 + \frac{z_p}{Q.z}}} \quad \text{(vi)}$$

$$\boxed{z' = z_p}$$

$$z' = z_p = \frac{z_p\left(-\frac{z}{Q.z} + 1 + \frac{z_p}{Q.z}\right)}{-\frac{z_p}{Q.z} + 1 + \frac{z_p}{Q.z}}$$

$$\boxed{z' = \frac{-z \cdot \frac{z_p}{Q.z} + z_p\left(1 + \frac{z_p}{Q.z}\right)}{-z \cdot \frac{1}{Q.z} + 1 + \frac{z_p}{Q.z}}} \quad \text{(vii)}$$

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & -\frac{Q.x}{Q.z} & z_p \cdot \frac{Q.x}{Q.z} \\ 0 & 1 & -\frac{Q.y}{Q.z} & z_p\frac{Q.y}{Q.z} \\ 0 & 0 & -\frac{z_p}{Q.z} & z_p\left(1 + \frac{z_p}{Q.z}\right) \\ 0 & 0 & -\frac{1}{Q.z} & 1 + \frac{z_p}{Q.z} \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

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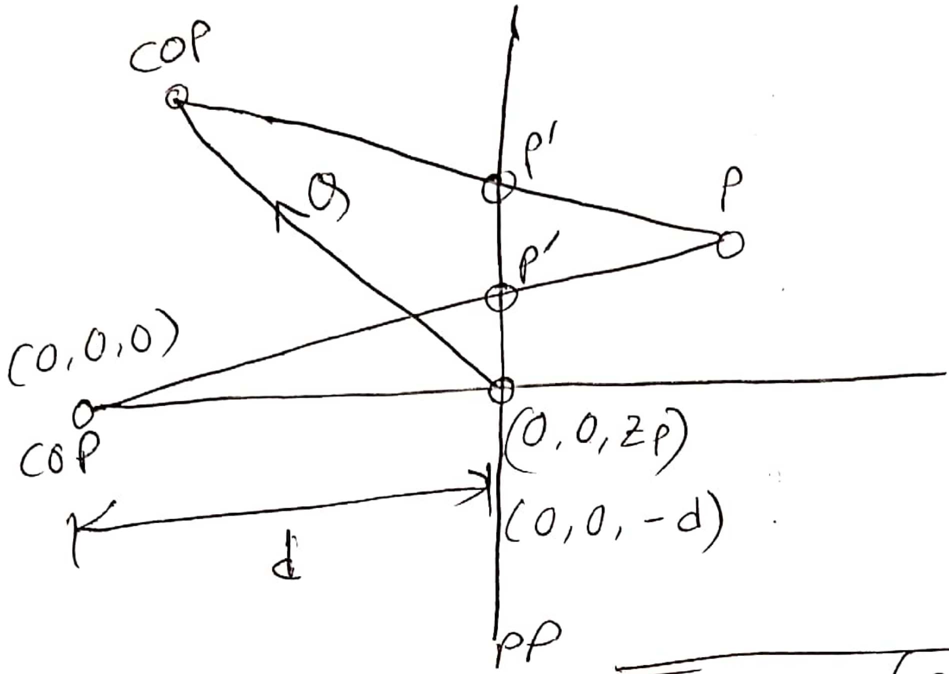

changing position of COP.

$\bar{Q} = (0,0,d)$; $\boxed{z_p = -d \ (Q.x = 0; Q.y = 0; Q_z = d)}$

~~origin at (0,0,0)~~

COP at $(0,0,0) = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -1/d & 0 \end{vmatrix}$

$$\begin{vmatrix} x' \\ y' \\ z' \\ 1 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -1/d & 0 \end{vmatrix} \cdot \begin{vmatrix} x \\ y \\ z \\ 1 \end{vmatrix}$$

আগের matrix with $z_p = -d$, $Q_x = 0$, $Q_y = 0$, $Q_z = d$

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origin at PP, $z_p = 0$

$Q_x = 0$

$Q_y = 0$

$Q_z = d$

Now,

$$\begin{vmatrix} x' \\ y' \\ z' \\ 1 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -1/d & 1 \end{vmatrix} \cdot \begin{vmatrix} x \\ y \\ z \\ 1 \end{vmatrix}$$

$\boxed{\text{DS}}$

Stratified class Distribution ***

Bootstrap

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stat extra → sunday 11:30 [online]

wednesday 2–3:20 [offline]

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