Multiple Choice Questions on 2D and 3D Transformation

1. The two-dimensional translation equation in the matrix form is

a) P’=P+T
b) P’=P-T
c) P’=P*T
d) P’=p

2. _____ is a rigid body transformation that moves objects without deformation.

a) Rotation
b) Scaling
c) Translation
d) All of the mentioned

3. The basic geometric transformations are

a) Translation
b) Rotation
c) Scaling
d) All of the mentioned

4. The transformation that is used to alter the size of an object is

a) Scaling
b) Rotation
c) Translation
d) Reflection

5. If the scaling factors values sx and sy are assigned to unequal values then

a) Uniform rotation is produced
b) Uniform scaling is produced
c) Differential scaling is produced
d) Scaling cannot be done

6. If the value of sx=1 and sy=1 then

a) Reduce the size of object
b) Distort the picture
c) Produce an enlargement
d) No change in the size of an object

7. If a ‘3 x 3’ matrix shears in Y direction, how many elements of it are ‘0’?

a) 2
b) 3
c) 6
d) 5

8. Shearing is also termed as _____

a) Selecting
b) Sorting
c) Scaling
d) Skewing

9. How many types of reflection is possible in a 3-dimensional environment?

a) 1
b) 3
c) 6
d) 9

10. Which of the following transformation can be used to change the shape of a 3D object in any particular axis?

a) Scaling
b) Rotation
c) Shearing
d) Translation

11. The positive value of the pivot point rotates an object in which of the following position?

a) Clockwise
b) Anti-Clockwise
c) Both Clockwise and Anti-Clockwise
d) Neither Clockwise nor Anti-Clockwise

12. Which of the following transformation changes the size of an object without changing its shape?

a) Translation
b) Rotation
c) Scaling
d) Reflection

13. Which of the following transformations flips an object across x-axis?

a) Translation
b) Rotation
c) Scaling
d) Reflection

14. What is the effect of rotating an object by 180 degrees?

a) The object is flipped horizontally
b) The object is flipped vertically
c) The object is rotated
d) The object is translated

17. Which transformation is used to distort the shape of an object by tilting it along one or more axes?

a) Shear transformation
b) Reflection
c) Scaling
d) Rotation

16. Which of the following formula is correct for z’ to perform 3D rotation along y-axis?

a) $z' = z\cos\Theta + x\sin\Theta$
b) $z' = z\cos\Theta - x\sin\Theta$
c) $z' = x\cos\Theta - z\sin\Theta$
d) $z' = -z\cos\Theta - x\sin\Theta$

17. Consider the rectangle with vertices (0,0), (0, 2), (3,0), (3,2). There is a scaling of 2 towards x-axis and 3 towards y-axis. The new coordiantes of the rectangle are

a) (0,0), (6,0), (0, 4), (6, 4)
b) (0, 0), (6,0), (0,4), (3,2)
c) (0,0), (6,0), (0, 6), (6,6)
d) (0,0), (4,0), (0, 6), (4, 6)

18. Which one is the correct matrix for performing 2D shear along y-axis?

a) $\begin{matrix} 1 & Shy & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$

b) $\begin{matrix} 1 & 0 & 0 \\ Shy & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$

c) $\begin{matrix} 1 & Shx & 0 \\ Shy & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$

d) $\begin{matrix} 1 & 0 & 0 \\ Shx & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$

19. Which matrix represent reflection on the line y = -x ?

a) $\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$

b) $\begin{matrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{matrix}$

c) $\begin{matrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{matrix}$

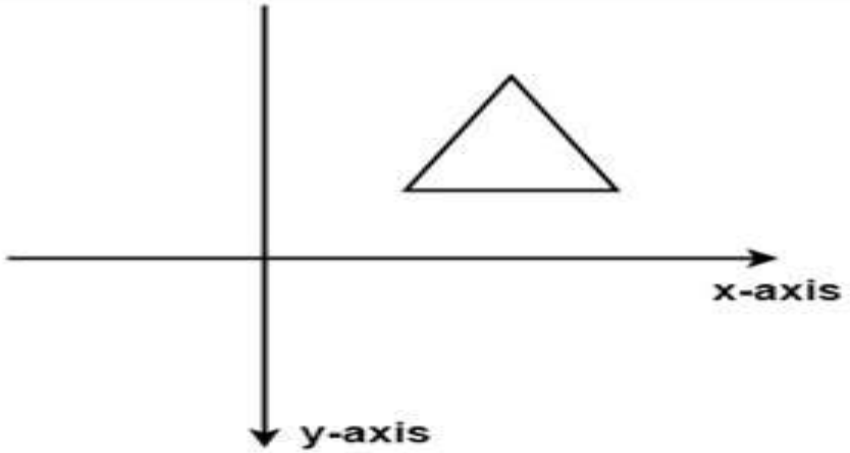
d) $\begin{matrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{matrix}$

20. Which of the following formula is correct for z’ to perform 3D rotation along y-axis?

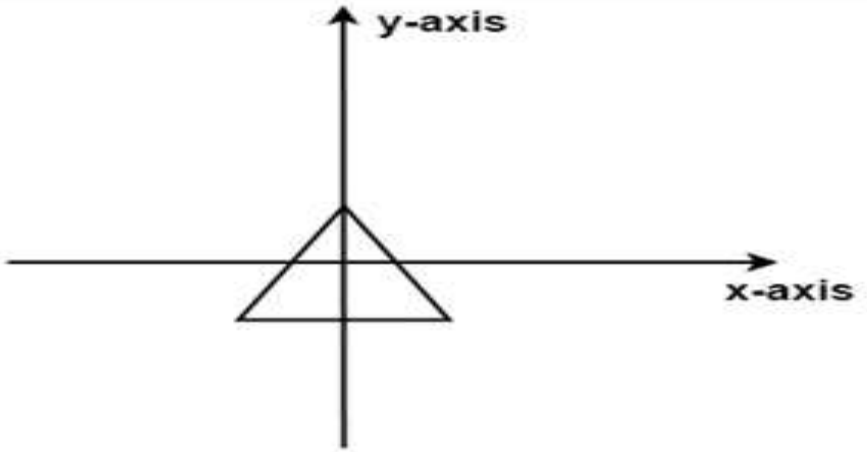
a) z’ = zcosΘ + xsinΘ
b) z’ = zcosΘ - xsinΘ
c) z’ = xcosΘ - zsinΘ
d) z’ = -zcosΘ - xsinΘ

Composite Transformation 2D and 3D

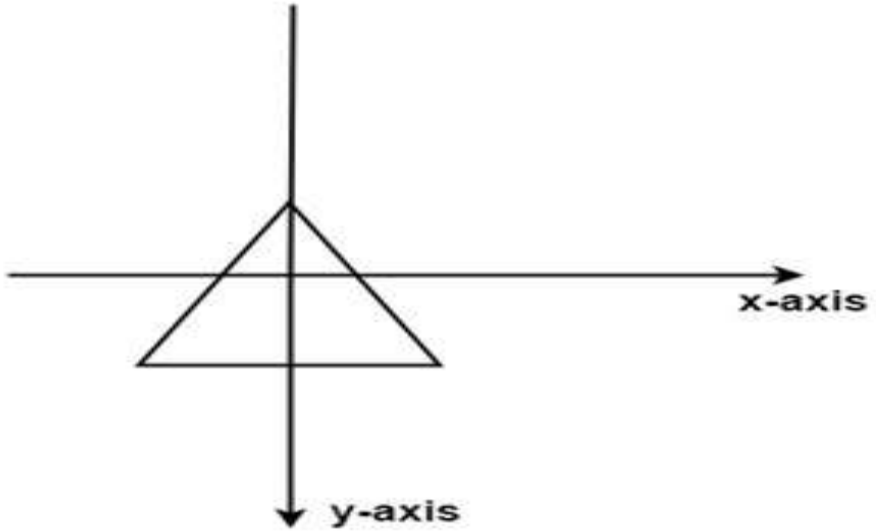
- A number of transformations or sequence of transformations can be combined into single one called as composition.
- The resulting matrix is called as composite matrix.
- The process of combining is called as concatenation.
- Suppose we want to perform scaling about a fixed point, then we can perform it by the sequence of three transformations
    1. Translation (T1)
    2. Scaling by factors Sx and Sy (S)
    3. Reverse Translation (T2)
- The ordering sequence of these numbers of transformations must not be changed.
- If a matrix is represented in column form, then the composite transformation is performed by multiplying matrix in order from right to left side.
- Composite matrix = T2 * S * T1



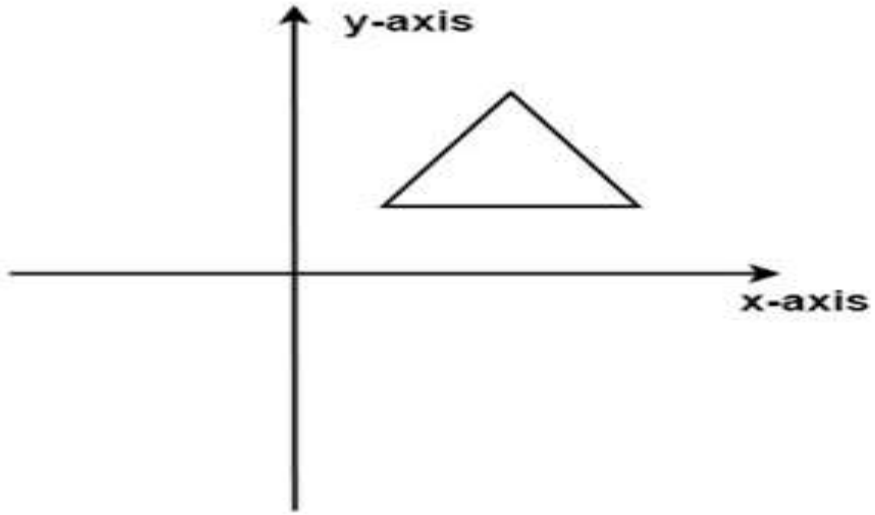
(original position of object)
Fig:(a)



(object is translated to origin)
Fig:(b)



(object is enlarged)
Fig:(c)



(object is retranslated to original position)
Fig:(d)

$$\text{Composite Matrix (C.M)} = \begin{matrix} 1 & 0 & -a \\ 0 & 1 & -b \\ 0 & 0 & 1 \end{matrix} * \begin{matrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & 1 \end{matrix} * \begin{matrix} 1 & 0 & a \\ 0 & 1 & b \\ 0 & 0 & 1 \end{matrix}$$

$$= \begin{matrix} Sx & 0 & a\,(1-Sx) \\ 0 & Sy & b\,(1-Sy) \\ 0 & 0 & 1 \end{matrix}$$

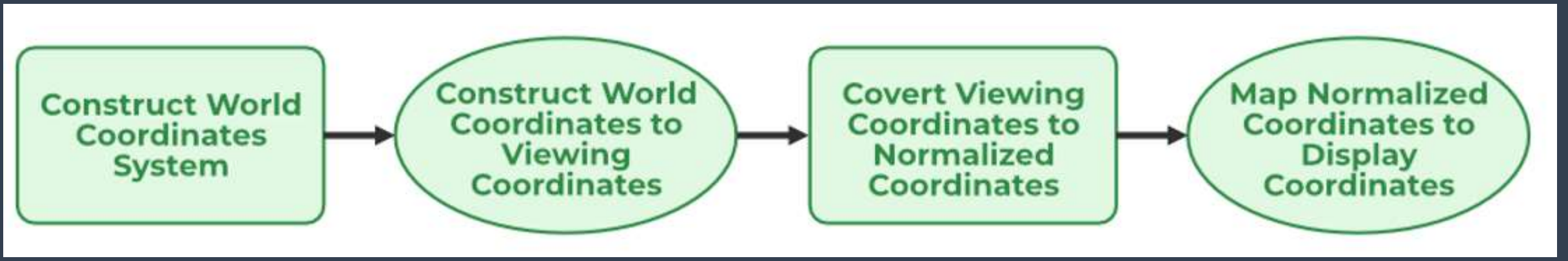
1. Which of the following is the correct order of transformations for a composite transformation that involves first scaling, then rotation and then translation?

a) Scale, rotate, translate
b) Rotate, scale, translate
c) Translate, rotate, scale
d) Translate, scale, rotate

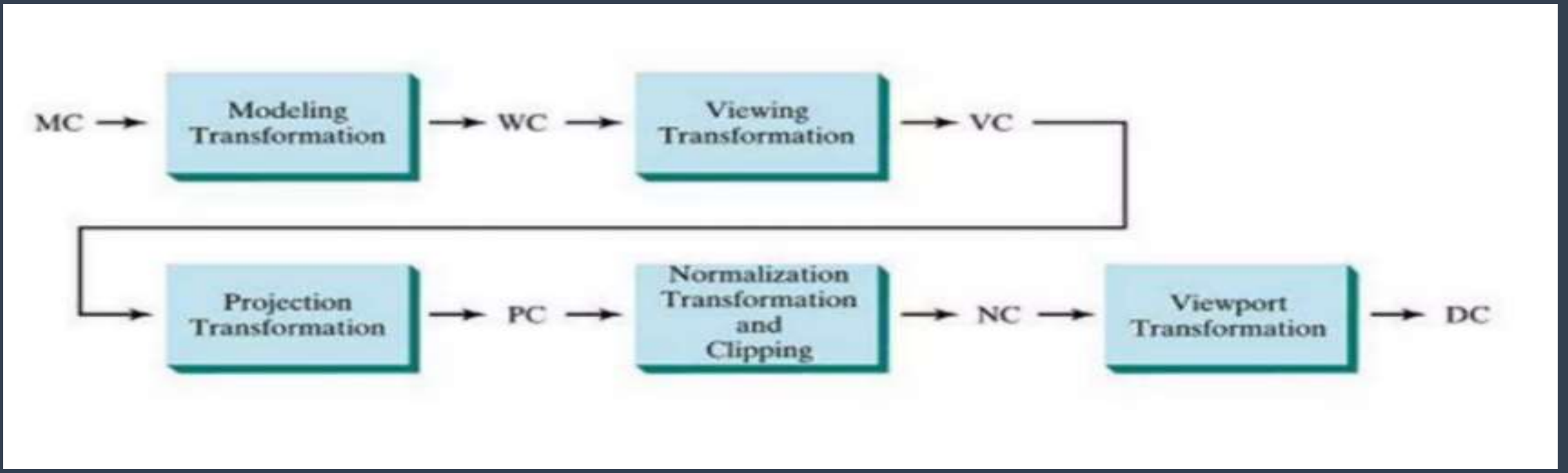
2. Which of the following composite transformation will produce a shearing effect?

a) Translation followed by rotation
b) Rotation followed by scaling
c) Scaling followed by reflection
d) Scaling followed by translation

Viewing Pipeling 2D and 3D



2D Viewing Pipeline



3D Viewing Pipeline

1. What is the first stage in the 2D viewing pipeline?

a) Object definition
b) Object transformation
c) Clipping
d) Window-to-viewport mapping

2. What stage involves transforming the 3D models into a form suitable for display on a 2D screen or other display device?

a) Modeling
b) Clipping
c) Viewing transformation
d) Projection

3. What is the purpose of clipping stage in the 2D viewing pipeline?

a) To convert a 2D image to 3D
b) To remove parts of the image outside view area
c) To covert the image to a raster format
d) To apply lighting and shading effects to a 3D model

4. What is the purpose of normalization stage in the 2D viewing pipeline?

a) To ensure that the objects are visible on the screen
b) To convert coordinates to normalized device coordinates
c) To project objects onto the screen
d) To transform objects to a common coordinate system

5. Which of the following co-ordinates are NOT used in 2d viewing transformation?

a) modelling co-ordinates
b) viewing co-ordinates
c) vector co-ordinates
d) device co-ordinates

6. How many steps are involved in converting the world coordinates of a scene to device coordinates?

a) 2
b) 3
c) 5
d) 7

7. Which of the following step involves in placing the object into appropriate position within the scene using their world coordinates?

a) Modelling Transformation
b) Viewing Transformation
c) Projection Transformation
d) Viewport Transformation

8. The object space or the space in which the application model is defined is called

a) World co-ordinate system
b) Screen co-ordinate system
c) World window
d) Interface window

9. What is the purpose of the clipping stage in the world to screen viewing transformation?

a) To remove parts of the image that are outside the viewing area
b) To apply lighting and shading effects to a 3D model
c) To convert the image to raster format
d) To remove hidden surfaces

10. What is the purpose of world to screen viewing transformation in computer graphics?

a) To convert a 2D image to 3D
b) To convert a 3D model to a 2D image for displaying on a screen
c) To remove hidden surfaces from a 3D model
d) To apply lighting and shading effects to a 3D model

11. What is the name of the space in which the image is displayed?

a) World co-ordinate system
b) Screen co-ordinate system
c) World window
d) Interface window

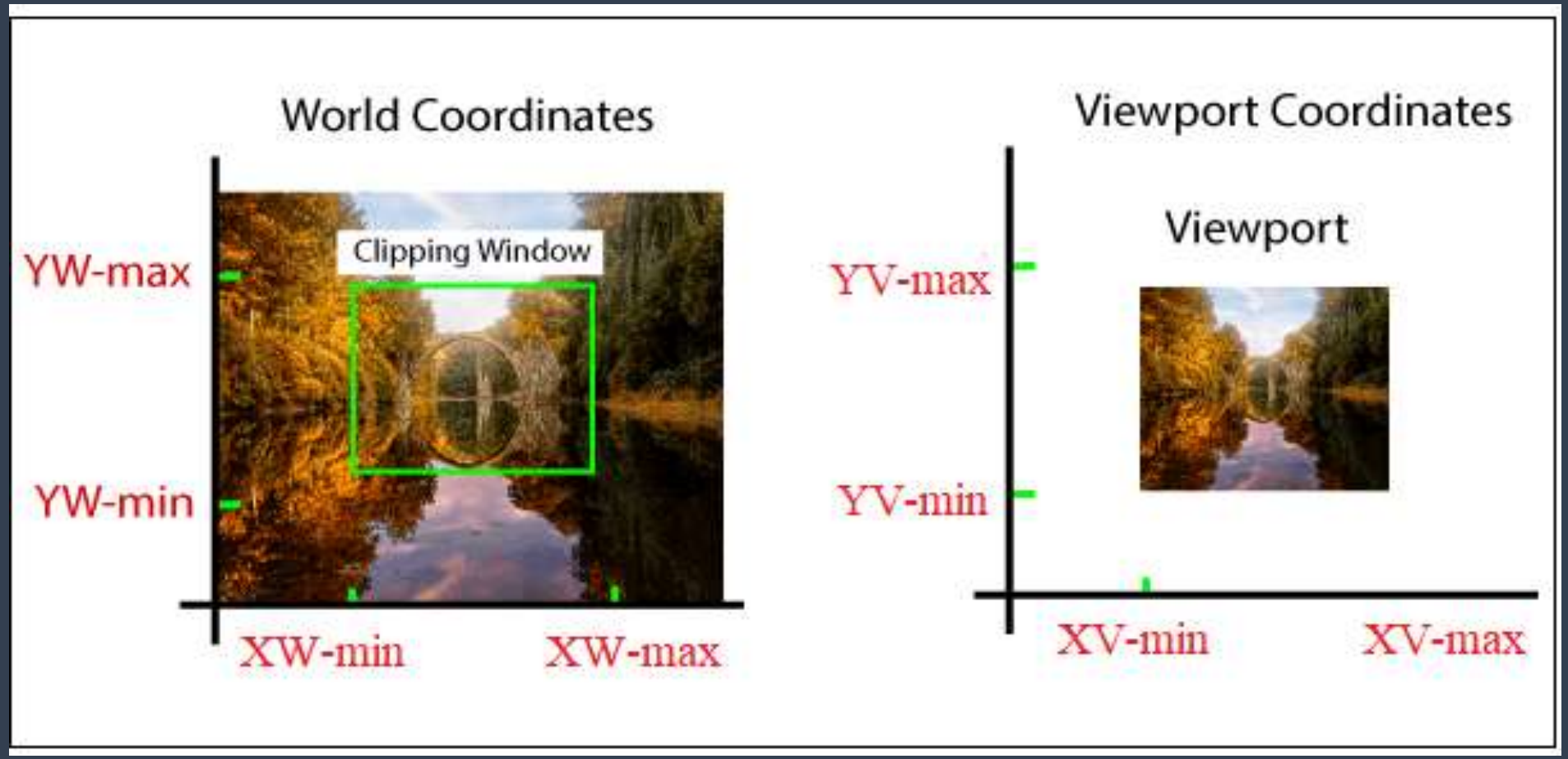
Clipping
and
Line Clipping Algorithm

Clipping

- Clipping in computer graphics refers to removing objects or parts of objects outside of the visible area of a computer screen or viewport.
- The viewing window (or viewport) often has a limited display area.
- Moreover, when rendering complex scenes, it’s essential to optimize performance by discarding objects or parts of objects that viewers can’t see.
- Clipping helps eliminate unnecessary calculations and improves the efficiency of rendering algorithms.
- Furthermore, it guarantees the display of only the visible portions of objects, resulting in faster rendering times and a more realistic representation of a scene.
- Clipping requires “Window” and “Viewport”.

Window and Viewport

- A window defines a rectangular area in world coordinates.
- A viewport defines in normalized coordinates a rectangular area on the display device where the image of the data appears.



Point Clipping

$$xwmin \leq x \leq xwmax$$

and

$$ywmin \leq y \leq ywmax$$

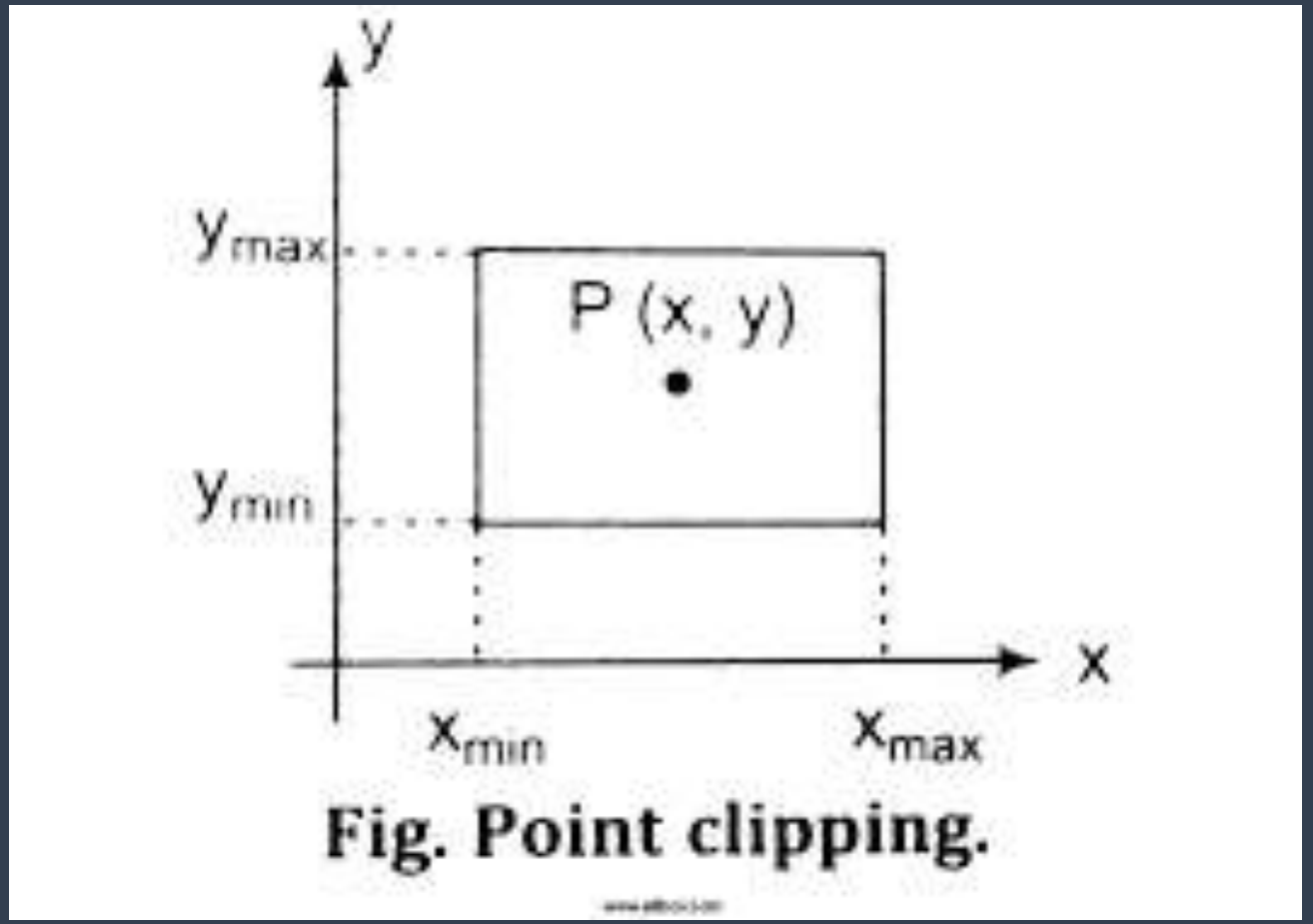
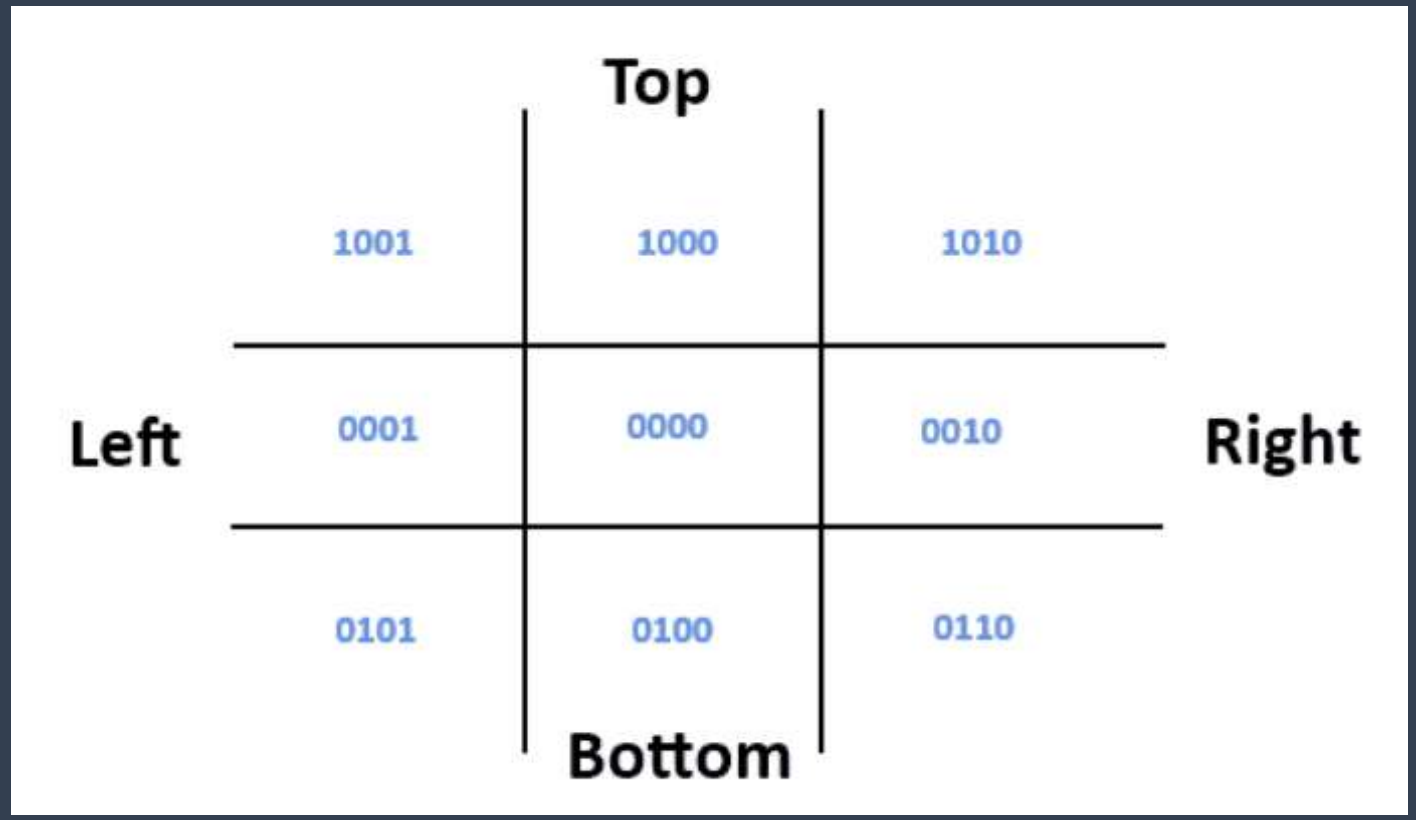
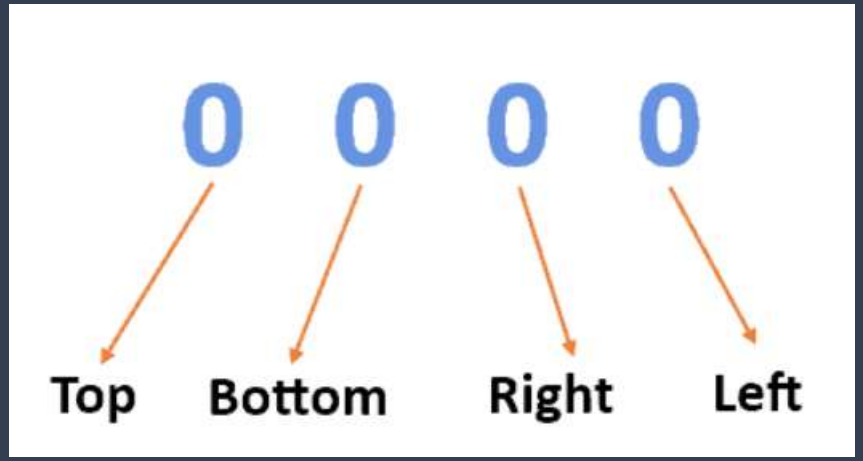


Fig. Point clipping.

Cohen-Sutherland Line Clipping

- The Cohen-Sutherland algorithm uses a region code to clip a portion of a line not present in the visible region.
- It divides a region into 9 cells based on (xwmin, ywmin) and (xwmax, ywmax)





Algorithm

1. Assign the 4-bit region codes to the end-points of line
2. If both are 0000, then accept the line trivally
3. If one of the region code is non-zero, the perform logical AND operation
    1. If the result of logical AND operation is non-zero, then reject the line without clipping
    2. If the result of logical AND operation is zero, then the line passes through the window and clipping is required
        1. Choose one of the points with non-zero region code
        2. Find the intersection point at the boundary of window with the formula
            $y-y1 = m(x-x1)$ where m is the slope of the line
        3. Update the line with the calculated intersection point along with its region code
    3. Repeat step 2 and 3 until the line is accepted or rejected

Liang-Barsky Line Clipping

- This algorithm is considered to be the faster parametric line-clipping algorithm.
- The following concepts are used in this clipping:
  - The parametric equation of the line.
  - The inequalities describing the range of the clipping window which is used to determine the intersections between the line and the clip window.
- The parametric equation of a line can be given by,

$$X = x1 + t(x2-x1)$$

$$Y = y1 + t(y2-y1)$$

- Where, t is between 0 and 1. Then, writing the point-clipping conditions in the parametric form:

$$xwmin <= x1 + t(x2-x1) <= xwmax$$

$$ywmin <= y1 + t(y2-y1) <= ywmax$$

- The above 4 inequalities can be expressed as,

$$tpk <= qk$$

Where k = 1, 2, 3, 4 (correspond to the left, right, bottom, and top boundaries, respectively).

The p and q are defined as,

p1 = -(x2-x1), q1 = x1 - xwmin (Left Boundary)

p2 = (x2-x1), q2 = xwmax - x1 (Right Boundary)

p3 = -(y2-y1), q3 = y1 - ywmin (Bottom Boundary)

p4 = (y2-y1), q4 = ywmax - y1 (Top Boundary)

Condition	Position of line
$p_k = 0$	parallel to the clipping boundaries
$p_k = 0$ and $q_k < 0$	completely outside the boundary
$p_k = 0$ and $q_k >= 0$	inside the parallel clipping boundary
$p_k < 0$	line proceeds from outside to inside
$p_k > 0$	line proceeds from inside to outside

Parameters t_1 and t_2 can be calculated that define the part of line that lies within the clip rectangle. When,

1. $p_k < 0$, maximum(0, q_k/p_k) is taken.
2. $p_k > 0$, minimum(1, q_k/p_k) is taken.

If $t_1 > t_2$, the line is completely outside the clip window and it can be rejected. Otherwise, the endpoints of the clipped line are calculated from the two values of parameter t.

1. What line clipping algorithm uses a 4-bit code to represent the location of a point?

a) Midpoint Line clipping
b) Cohen-Sutherland line clipping
c) Liang-Barsky line clipping
d) Bresenham's line clipping

2. Which clipping algorithm uses the concept of parameterization?

a) Cohen-Sutherland line clipping
b) Liang-Barsky Line Clipping
c) Midpoint Line Clipping
d) Bresenham's Line Clipping

3. Which clipping algorithm uses the concept of window to define the viewing area?

a) Cohen-Sutherland line clipping
b) Liang-Barsky Line Clipping
c) Midpoint Line Clipping
d) Bresenham's Line Clipping

4. What is the advantage of Liang-Barsky line clipping over Cohen-Sutherland line clipping?

a) It is faster
b) It is easier to implement
c) It is more accurate
d) It is more widely used

5. The Cohen-Sutherland algorithm divides the region into _____ number of spaces.

a) 8
b) 6
c) 7
d) 9

6. The top-right region of the window can be represented as_____

a) 0000
b) 1111
c) 0110
d) 1010

7. The logical _____ of the endpoint codes determines if the line is completely inside the window.

a) AND
b) OR
c) NOT
d) NOR

8. When the line is parallel to the boundaries then what is the value of pk?

a) $pk < 0$
b) $pk > 0$
c) $pk = 0$
d) $pk = 1$

9. How many inequalities are solved in this algorithm?

a) 3
b) 2
c) 1
d) 4

10. When pk < 0, then the line is _____

a) parallel to the boundaries
b) exceeding the boundaries
c) bounded inside the boundaries
d) can’t say

11. What is the relative speed improvement over Cohen-Sutherland algorithm for 2-D lines?

a) 40%
b) 50%
c) 70%
d) 36%

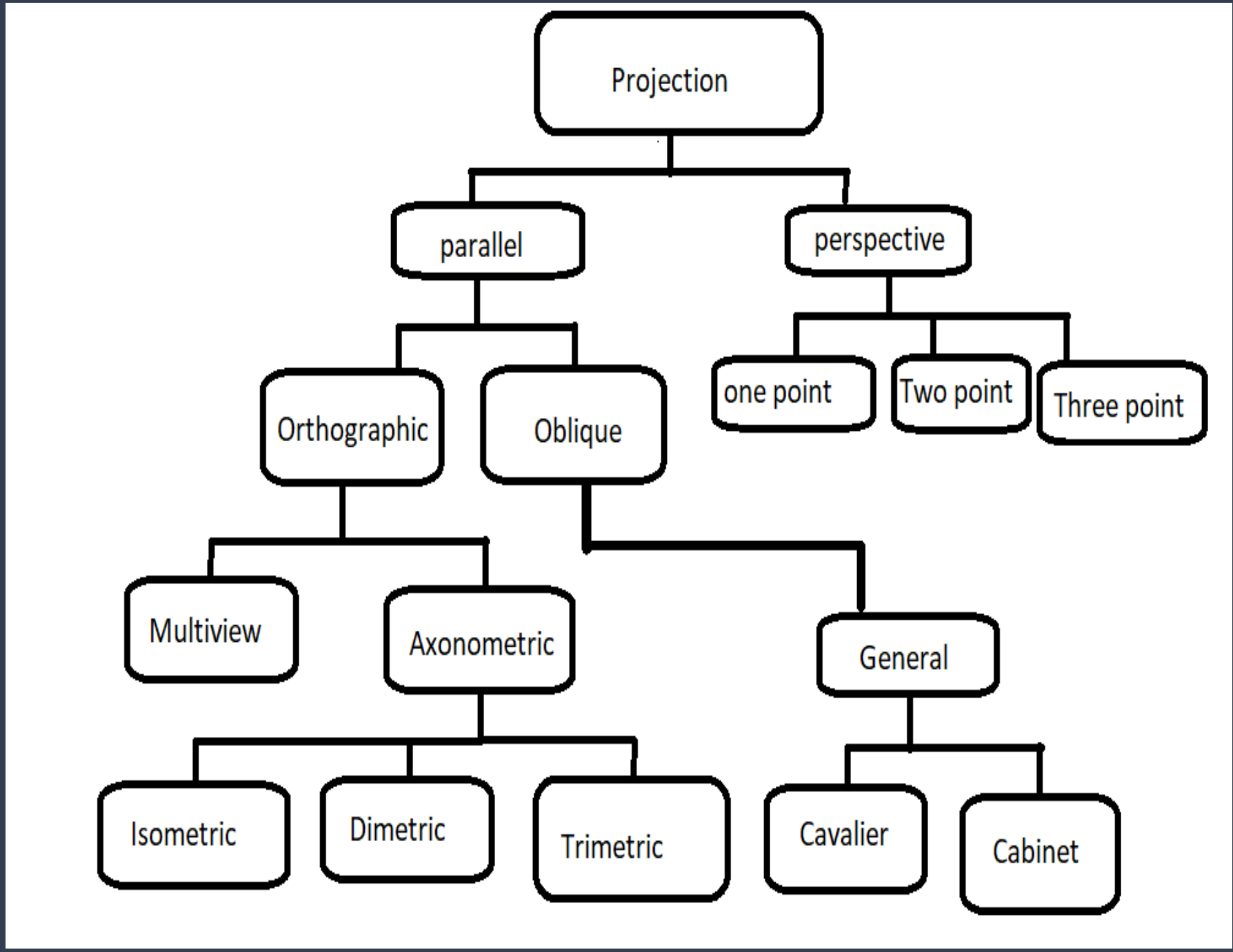
12. Liang–Barsky algorithm is a _____ clipping algorithm.

a) circle
b) text
c) line
d) pixel

Concept of Projection

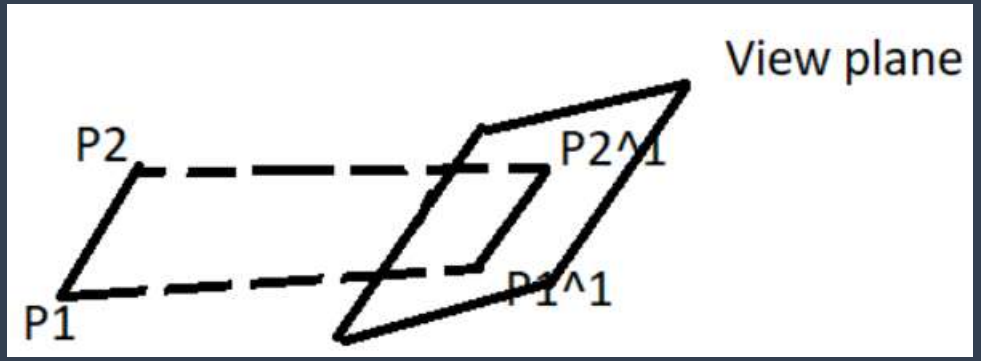
Representing an n-dimensional object into an n-1 dimension is known as projection.

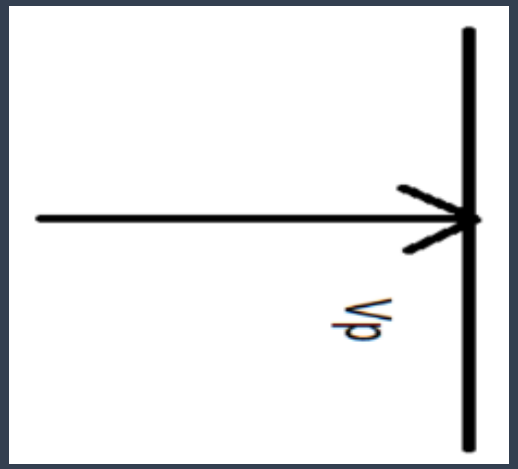
It is process of converting a 3D object into 2D object, we represent a 3D object on a 2D plane {(x,y,z)->(x,y)}.



Parallel Projection

A parallel projection is the one where the lines of projection are parallel to each other.



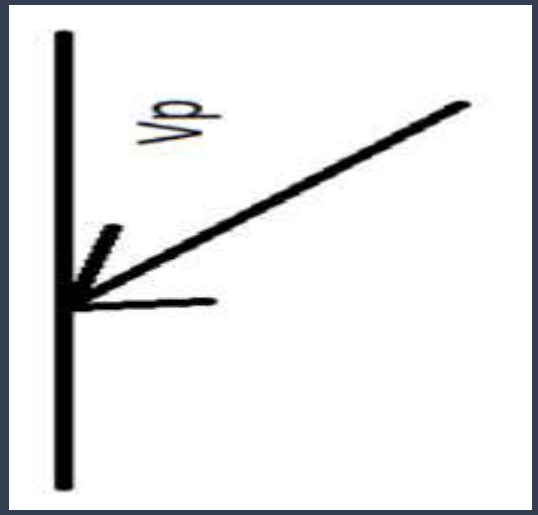


Orthographic Parllel Projection

The lines of projection make an angle of 90 degree with the projection plane.

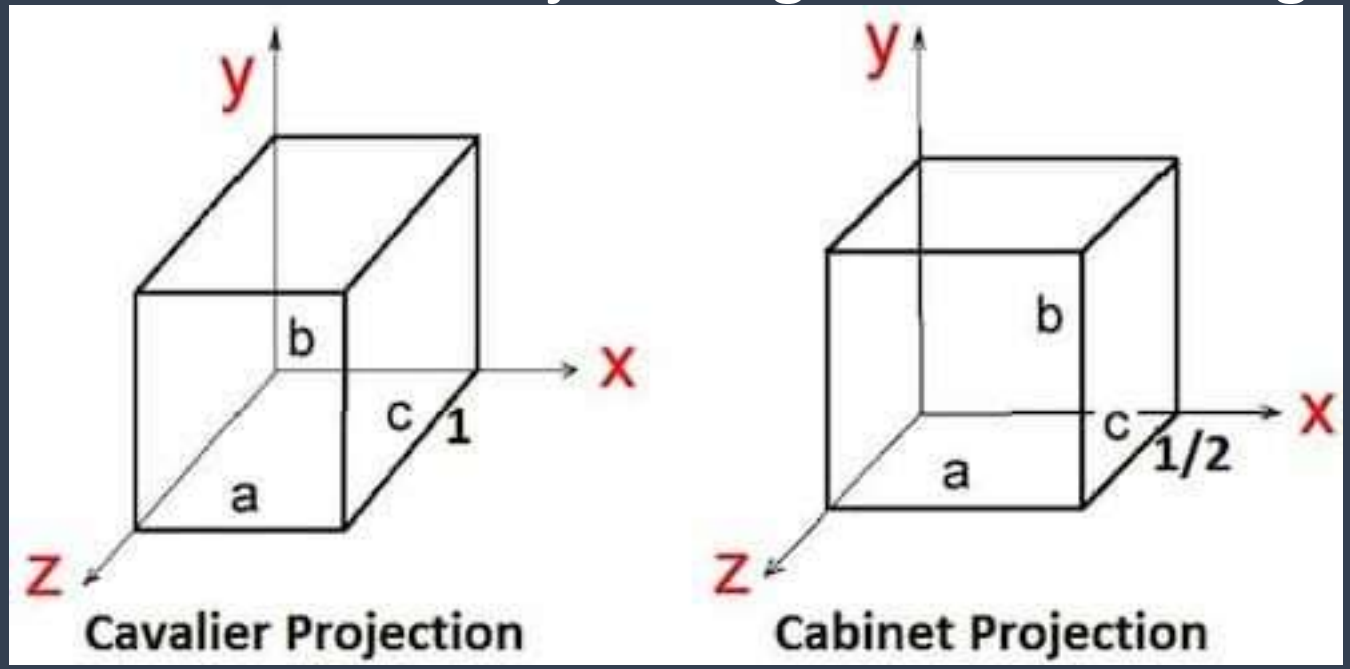
Oblique Parallel Projection

The lines of projection make an angle other than 90 degree with the projection plane.



Cavalier Projections:

All lines perpendicular to the projection plane are projected with no change in length. If the projected line making an angle 45 degrees with the projected plane, as a result the line of the object length will not change.



Cabinet Projections:

All lines perpendicular to the projection plane are projected to one half of their length. These gives a realistic appearance of object. It makes 63.4 degrees angle with the projection plane. Here lines perpendicular to the viewing surface are projected at half their actual length.

1. Which types of lines are used to transform coordinate points to the view plane in parallel projection?

a) Intersecting Lines
b) Parallel Lines
c) Perpendicular Lines
d) Bisecting Lines

2. Which type of parallel projection has projection vectors perpendicular to the viewing plane?

a) Axonometric Projection
b) Orthographic Projection
c) Oblique Projection
d) Perspective Projection

3. In cabinet projection, what is the projected length of the lines that are perpendicular to the viewing plane?

a) Same length as the original
b) Double the length of the original
c) Half the length of the original
d) Projected length does not depend on the original length

4. Lines of sights (projectors) for oblique projection will be _____
a) Parallel to each other and perpendicular to projection plane
b) Not parallel to each other and perpendicular to projection plane
c) Parallel to each other and inclined to projection plane
d) Not parallel to each other and inclined to projection plane

5. When the receding lines are drawn to full size scale then the oblique projection is

a) Cabinet projection
b) Isometric projection
c) Orthographic projection
d) Cavalier projection

6. In perspective projection, what happens to the size of the image when the object moves far from the projection plane?

a) There is no change in size of image
b) Size of image gets bigger
c) Size of image gets smaller
d) There is no image in perspective projection

7. How many axis intersects with the projection plane in the three-point perspective projection?

a) One
b) Two
c) Three
d) No axis intersects the projection plane

8. Which of the following projection types preserves the relative sizes and shapes of the object being projected?

a) Perspective Projection
b) Orthogrpaphic Projection
c) Isometric Projection
d) Oblique Projection

9. Which projection type is based on converging projection lines?

a) Orthographic Projection
b) Perspective Projection
c) Oblique Projection
d) Isometric Projection

10. What is the frustum in projection concepts?

a) A cone-shaped volume
b) A cube-shaped volume
c) A pyramid-shaped volume
d) A sphere-shaped volume

11. Which type of projection creates a 2D image that accurately mimics the way objects appear in the real world?

a) Orthographic Projection
b) Perspective Projection
c) Oblique Projection
d) Isometric Projection

12. What is foreshortening in projection?

a) Creating 2D image with same size/shape of object
b) Creating 2D image same as in real world
c) Converging projection lines to make image smaller and compressed
d) Projection lines are parallel