CLIPPING

clipping :- It consist of

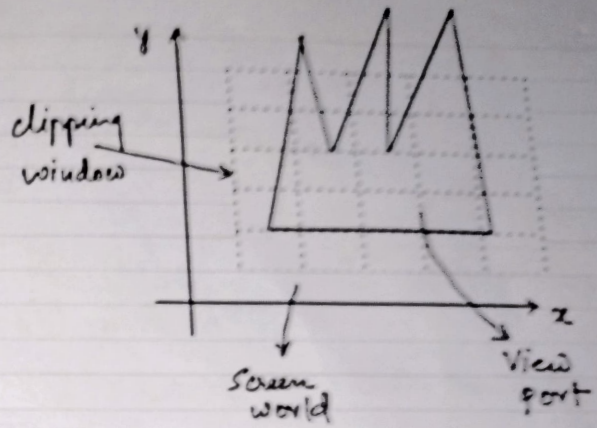
- ↳ window
- ↳ View port
- ↳ Computer Screen

It consist of -

$\{x_{min}, x_{max}, y_{min}, y_{max}\}$

is called window.

* It follow the world - coordinate system.

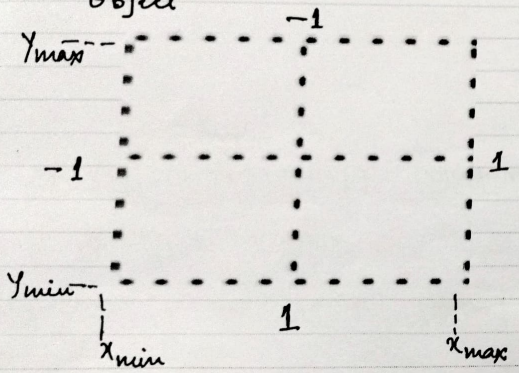


Application of clipping :-

`gluOrtho2D()`

1. It will extract the part to display.
2. Identify the visible and invisible in 3D object.
3. Creating the solid Model.

④ Deleting, copying part of the object.



Types of clipping :-

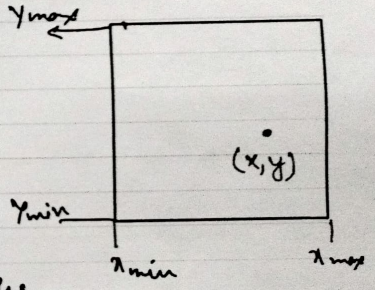
① Point clipping
② Line clipping
③ Area clipping
④ Curve clipping
⑤ Text clipping
⑥ Exterior clipping.

Point Clipping :- It is used to determine the point is inside the window or outside the window.

↳ If the point is coming inside the clipping window we have to display, otherwise no need to display.

↳ Rules for Clipping :-

① $x \leq x_{max}$
② $x \geq x_{min}$
③ $y \leq y_{max}$
④ $y \geq y_{min}$



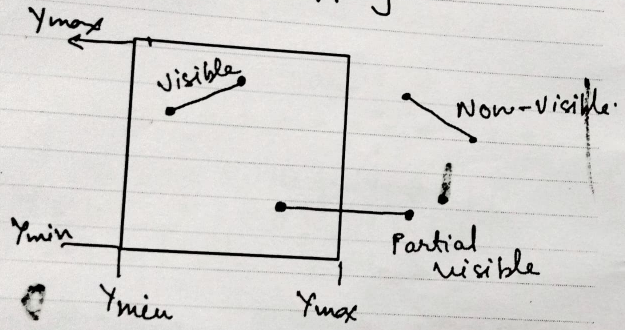
Thus, the point lies the clipping windows

$$x_{min} \leq x \leq x_{max}$$
$$y_{min} \leq y \leq y_{max}$$

Line Clipping :-

↳ Inside the Rule.

↳ Outside the window called the line clipping.



↳ It is performed by two different Algorithm :-

① Cohen - Sutherland clipping Algorithm.

② Liang - Barsky Line clipping Algorithm.

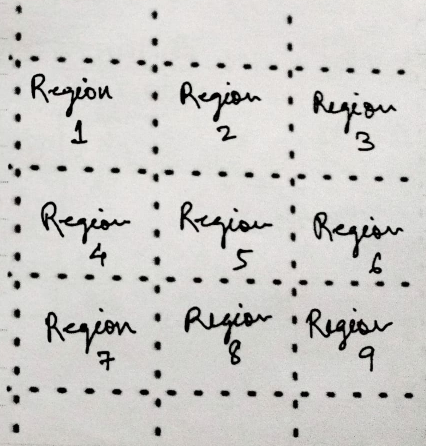
Cohen Sutherland clipping Algorithm

Lets take the screen :-

↳ It uses 4-bit data for storage.

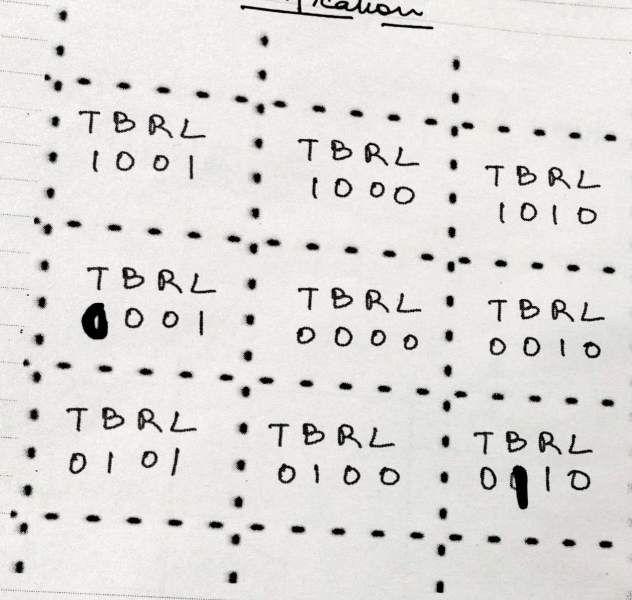
↳ Divide the screen into 9(Nine) region

↳ Assign the code based on (TBRL).



Region Division

Codification

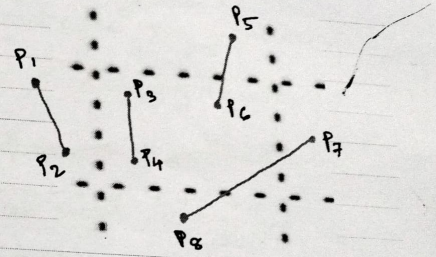


T: $y > y_{max}$ (assign 1)
R: $x > x_{max}$ (assign 1)
B: $y < y_{min}$ (assign 1)
L: $y < x_{min}$ (assign 1)

Q. Write each region code.

Truth Table

A	B	O/P
0	0	0
0	1	0
1	0	0
1	1	1



If the value is Non-Zero then it indicates that it is completly outside the window.

(Reject the lines)

Case 1:- Region Code (P_1 and P_2)

$P_1 = 0001$
$P_2 = 0001$
0001 → Reject the line

} Apply AND operation

Case 2:- P_3 and P_4

$P_3 = 0000$
$P_4 = 0000$
0000 } AND operation

If all the value is "Zero" then it indicates all the value is inside the window.

→ No clipping is required

→ Accept the line

Case 3:- P_5 and P_6

$P_5 = 1000$
$P_6 = 0000$
0000 } AND operation

It indicates some portion lies inside and some portion lies outside the window.
{ Clipping is Required }

Now check the intersection Point

$P_5' = 0000$
$P_6 = 0000$
0000 } AND operation

Accept P_5' and P_6

Case 4:- P_7 and P_8

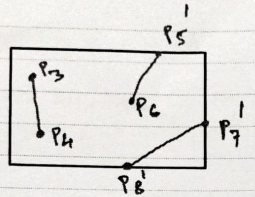
$P_7 = 0010$
$P_8 = 0100$
0000 } AND operation

It indicates both the point is outside the window.
(It indicates clipping)

Now, check the intersection Point.

$P_7' = 0000$
$P_8' = 0000$
0000 } AND operation. Accept P_7' and P_8'

Final O/p



Algorithm :-

Step 1:- For each region the 4-bit code is assign based on the (TBRL).

Step 2:- The line is accepted

→ if, end point have a region code (0000)

→ else, the logical AND operation is performed for both regions code.

Step 3:- If the result is not (0000) then reject the line.

→ else clipping is required.

→ The end point is selected that is outside the window.

→ Find the intersection point of clipping window.

→ The end pt is replaced with interaction point & region code is updated.

→ Repeat Step 2 until we find clipped lines.

Step 4:- Repeat step 1 for the line.

Liang Barsky Line Clipping Algorithm

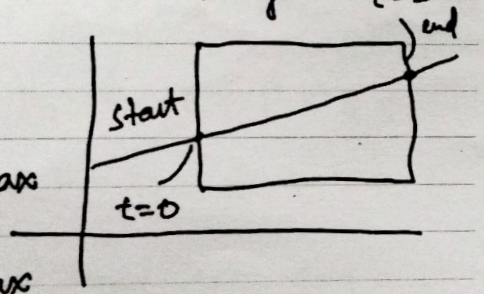
The algorithm is used to trace the line w.r.to line and distance.

$$x = x_1 + t\Delta x; \quad y = y_1 + t\Delta y; \quad [0 < t \leq 1]$$

$$\Delta x = x_2 - x_1 \quad \& \quad \Delta y = y_2 - y_1$$

For Point Selection

If the point is inside the rectangle iff :-



$$x_{min} \leq x_1 + t\Delta x \leq x_{max}$$

$$y_{min} \leq y_1 + t\Delta y \leq y_{max}$$

Based on the condition we have created four inequalities which is expressed as

$$\boxed{tp_k \leq q_k}$$

Here, $k = 1, 2, 3, 4$.

The initial condition are:-

$x > x_{min}$	$y > y_{min}$
$x < x_{max}$	$y < y_{max}$

based on the condition we have

$$x_1 + t\Delta x \geq x_{min} \quad -(1)$$

$$x_1 + t\Delta x \leq x_{max} \quad -(2)$$

$$y_1 + t\Delta y \geq y_{min} \quad -(3)$$

$$y_1 + t\Delta y \leq y_{max} \quad -(4)$$

Here:-

$$t\Delta x \geq x_{min} - x_1 \quad -(1)$$

$$t\Delta x \leq x_{max} - x_1 \quad -(2)$$

$$t\Delta y \geq y_{min} - y_1 \quad -(3)$$

$$t\Delta y \leq y_{max} - y_1 \quad -(4)$$

Multiply "(-1)" with eq^{n} ① and ③

$$-t\Delta x \leq x_1 - x_{min}$$

$$-t\Delta y \leq y_1 - y_{min}$$

Now, p_k and q_k where $k = 1, 2, 3, 4$

$p_1 = -\Delta x$, $q_1 = x_1 - x_{min}$

$p_2 = \Delta x$, $q_2 = x_{max} - x_1$

$p_3 = -\Delta y$, $q_3 = y_1 - y_{min}$

$p_4 = \Delta y$, $q_4 = y_{max} - y_1$

} Proof

Case 1 :- If any $[p_k = 0]$ line is ||el to window. Then,

$q_k < 0$; Line outside.

$q_k > 0$; Line inside

$q_k = 0$; within the boundary

Case II :- if $[p_k < 0]$ then find 't_1' initial Time.

$$t_1 = \max\left[0, \frac{q_k}{p_k}\right] \quad [t_1 \neq 0] \text{ outside}$$

$$x = x_1 + t_1 \Delta x$$

$$y = y_1 + t_1 \Delta y$$

Case III :- If $[p_k > 0]$ then find the (t_2) end line.

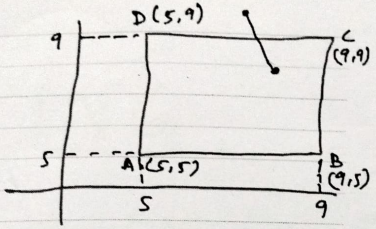
$$t_2 = \min\left[1, \frac{q_k}{p_k}\right] \quad [t_2 \neq 1] \text{ outside.}$$

$$x = x_1 + t_2 \Delta x$$

$$y = y_1 + t_2 \Delta y$$

iside the c'
region

Q A (5,5)
B (9,5)
C (9,9)
D (5,9)



Lines is present at $(x_1, y_1) = (4, 12)$ and $(x_2, y_2) = (8, 8)$

Sol:-

Step 1:- $\Delta x = x_2 - x_1 = (8-4) = 4$

$\Delta y = y_2 - y_1 = (8-12) = -4$

Step 2:- check with the given equalities.

$P_1 = -\Delta x = -4$	$q_1 = x_1 - x_{min} = 4-5 = 1$
$P_2 = \Delta x = 4$	$q_2 = x_{max} - x_1 = 9-4 = 5$
$P_3 = -\Delta y = 4$	$q_3 = y_1 - y_{min} = 12-5 = 7$
$P_4 = \Delta y = -4$	$q_4 = y_{max} - y_1 = 9-12 = 3$

Step 3:- Case 1:- if $[P_k = 0]$ then line is ||-el to windows.

Case 2:- If $[P_k < 0]$ then find t_1

$t_1 = \max\left[0, \frac{q_k}{P_k}\right]$

$= \left[0, -\frac{1}{4}, \frac{-3}{-4}\right]$

$= 3/4$ is max

$x = x_1 + t_1 \Delta x$ | $y = y_1 + t_1 \Delta y$

$= 4 + 3/4 * 4$ | $= 12 + 3/4 \times -4$

$= 7$ | $= 9$

Case 3:- If $[P_k > 0]$ then find 't_2'

$t_2 = \min\left[1, \frac{q_k}{P_k}\right]$

$$= \min\left[1, \frac{5}{4}, \frac{7}{4}\right]$$

$$\boxed{t_2 = 1}$$ no clipping

O/P window :-