

16. Clipping Lines and Polygons

14 February 2024 15:34

Source: Computer Graphics by Donald Hearn and M. Pauline Baker

Clipping :-

A procedure that identifies those portions of a picture that are either inside or outside of a specified region of space is called Clipping.

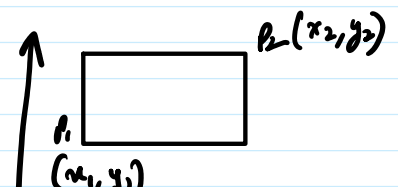
The region against which an object is to be clipped is called a clip window.

- ① Point Clipping
- ② Line Clipping
- ③ Area Clipping (polygons)
- ④ Curve Clipping
- ⑤ Text Clipping

Point Clipping :-

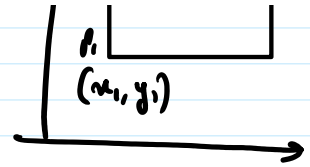
Assuming that clip window is a rectangle in standard position, a point $P = (x, y)$ is displayed if it satisfies :-

$$x_{w_{min}} \leq x \leq x_{w_{max}}$$



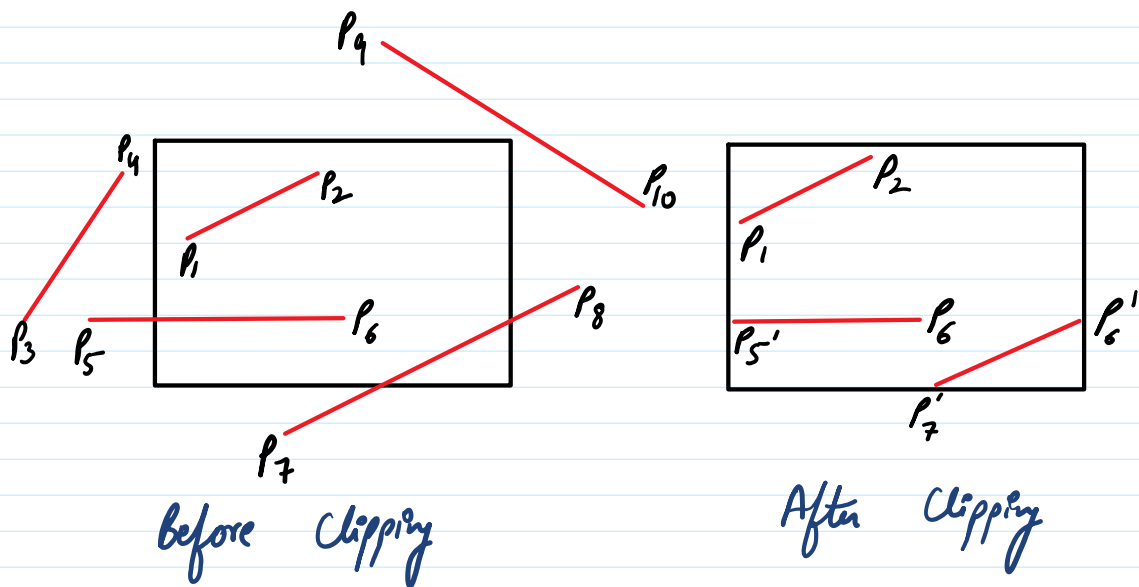
$$x_{w_{min}} \leq x \leq x_{w_{max}}$$

$$y_{w_{min}} \leq y \leq y_{w_{max}}$$



where $(x_{w_{min}}, x_{w_{max}}, y_{w_{min}}, y_{w_{max}})$ are the edges of the clip window.

Line Clipping :-



Cohen-Sutherland Line Clipping :-

Oldest and most popular

Every line end-point in a picture is assigned a four-digit binary code, called region code.

Region Code identifies the location of the point relative to the boundaries of the clipping rectangle.

Each bit position is used to indicate one of the four relative to the coordinate positions.

bit 1 \rightarrow left
 bit 2 \rightarrow right
 bit 3 \rightarrow below
 bit 4 \rightarrow above

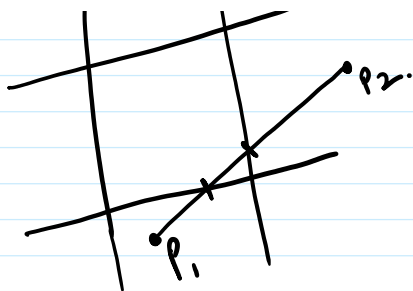
1001	1000	1010	$\overline{\uparrow}$ above
0001	0000 Window	0010	$\overline{\uparrow}$ below
0101	0100	0110	$\overline{\uparrow}$ right
			$\overline{\uparrow}$ left

- ① Assign region code for each end point.
- ② The line is accepted if both end points have a region code 0000.
- ③ If not accepted,
 - Logical AND operation with both region codes.
 - \rightarrow If the result is not 0000 the reject the line.
 - \rightarrow Else clip.



① Select a point which is outside the window

② Find the intersection point



② Find the intersection point at the window boundary

③ End point is replaced with the intersection point, update.

Intersection points

Let endpoint coordinates of line be (x_1, y_1) and (x_2, y_2) , the y coordinate of the intersection point with a vertical boundary,

$$y = y_1 + m(x - x_1)$$

$x \rightarrow$ can be either x_{wmin} or x_{wmax} .

$$m \rightarrow \frac{y_2 - y_1}{x_2 - x_1}$$

Similarly, intersection with a horizontal boundary

$$x = x_1 + \frac{y - y_1}{m}$$

$y \rightarrow y_{wmin}$ or y_{wmax}

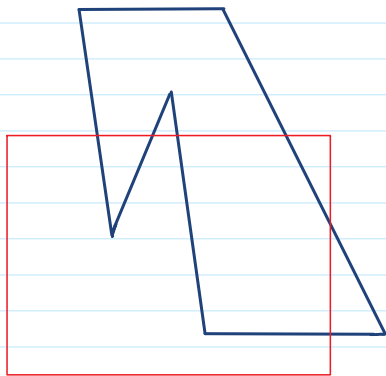
Reading Exercises :-

“Liang-Barsky Line Clipping”

“Nicholl-Lee-Nicholl Line Clipping”

Polygon Clipping :-

The output of a polygon clipper is a sequence of vertices that defines the clipped polygon boundaries.

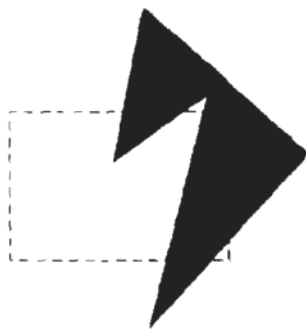


Before Clipping



After Clipping

Polygon processed by a
line-clipping algorithm.



Before Clipping



After Clipping

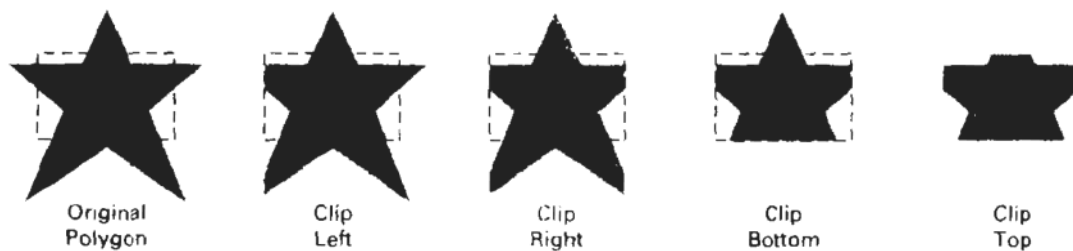
A correctly clipped polygon

For polygon clipping, we require an algorithm

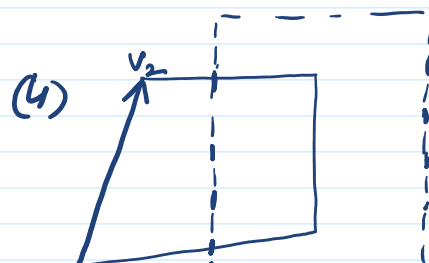
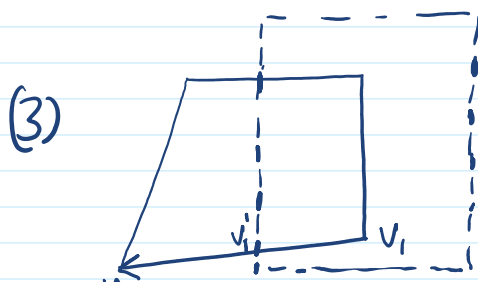
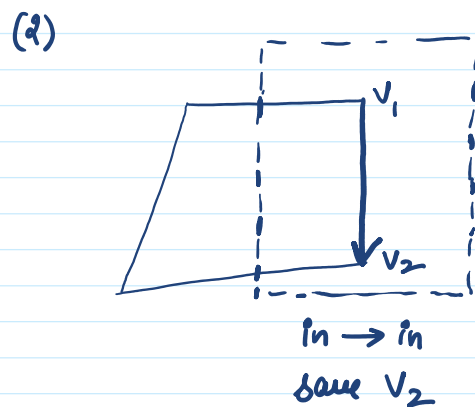
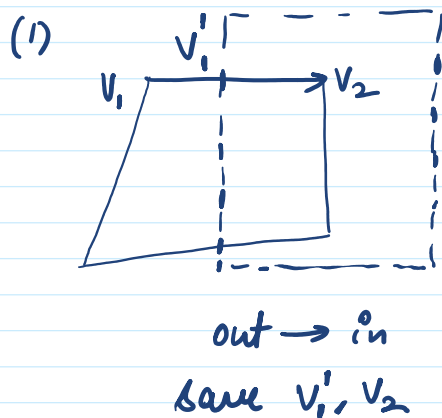
that will generate one or more closed areas that are then scan converted for the appropriate area fill.

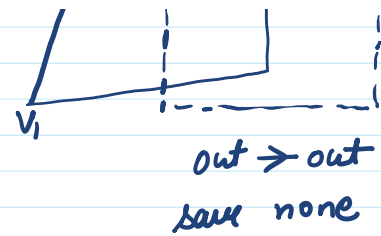
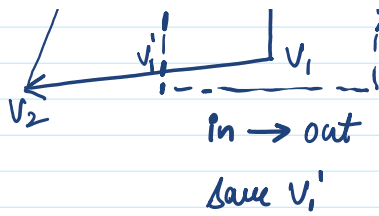
Sutherland - Hodgeman Polygon Clipping:-

by processing the polygon boundary as a whole against each window edge.

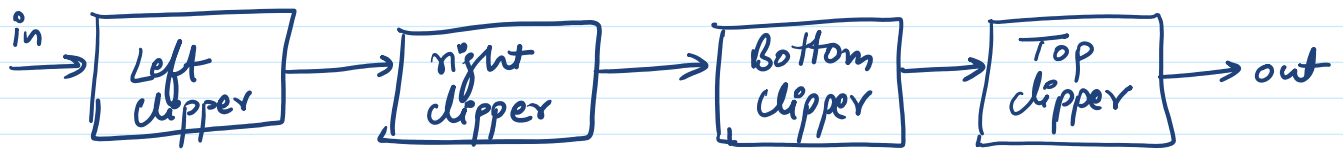


To obtain new sequence of vertices,
four cases





Processing of pairs of polygon vertices against the left window boundary.



Reading Exercise:—

“Weiler-Atherton Polygon Clipping”