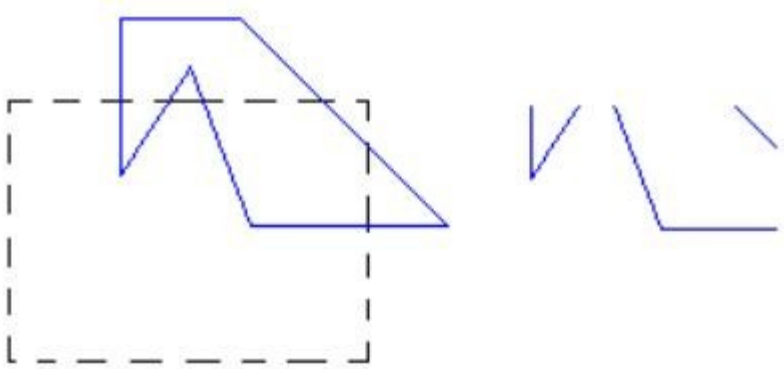
Computer Graphics

Clipping

- *Sutherland-Hodgman Algorithm (Area Clipping or Polygon Clipping)*
- *Weiler-Atherton Polygon Clipping (Solution of Sutherland-Hodgman Algorithm)*
- *Cohen Sutherland Algorithm (Line Clipping)*

Area Clipping (polygons)

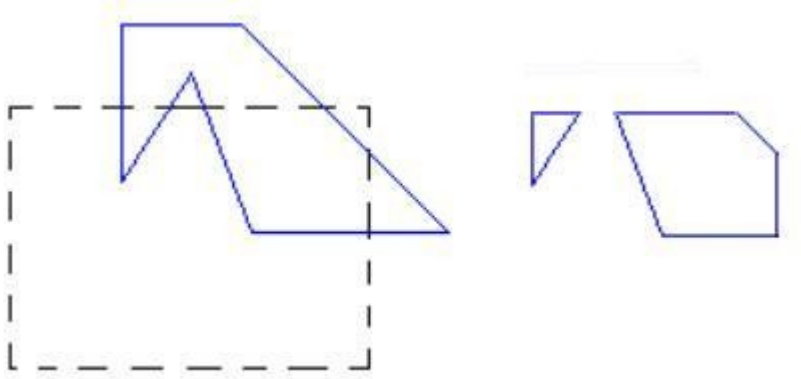
To clip a polygon, we cannot directly apply a line-clipping method to the individual polygon edges because this approach would produce a series of unconnected line segments as shown in figure .



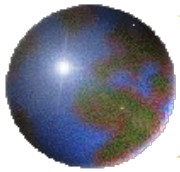
Area Clipping (polygons)

The clipped polygons must be a bounded area after clipping as shown in figure.

Concave Polygon

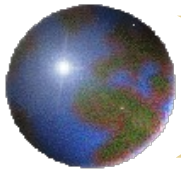


- *For polygon clipping, we require an algorithm that will generate one or more closed areas that are then scan converted for the area fill.*
- *The output of a polygon clipper should be a sequence of vertices that defines the clipped polygon boundaries.*

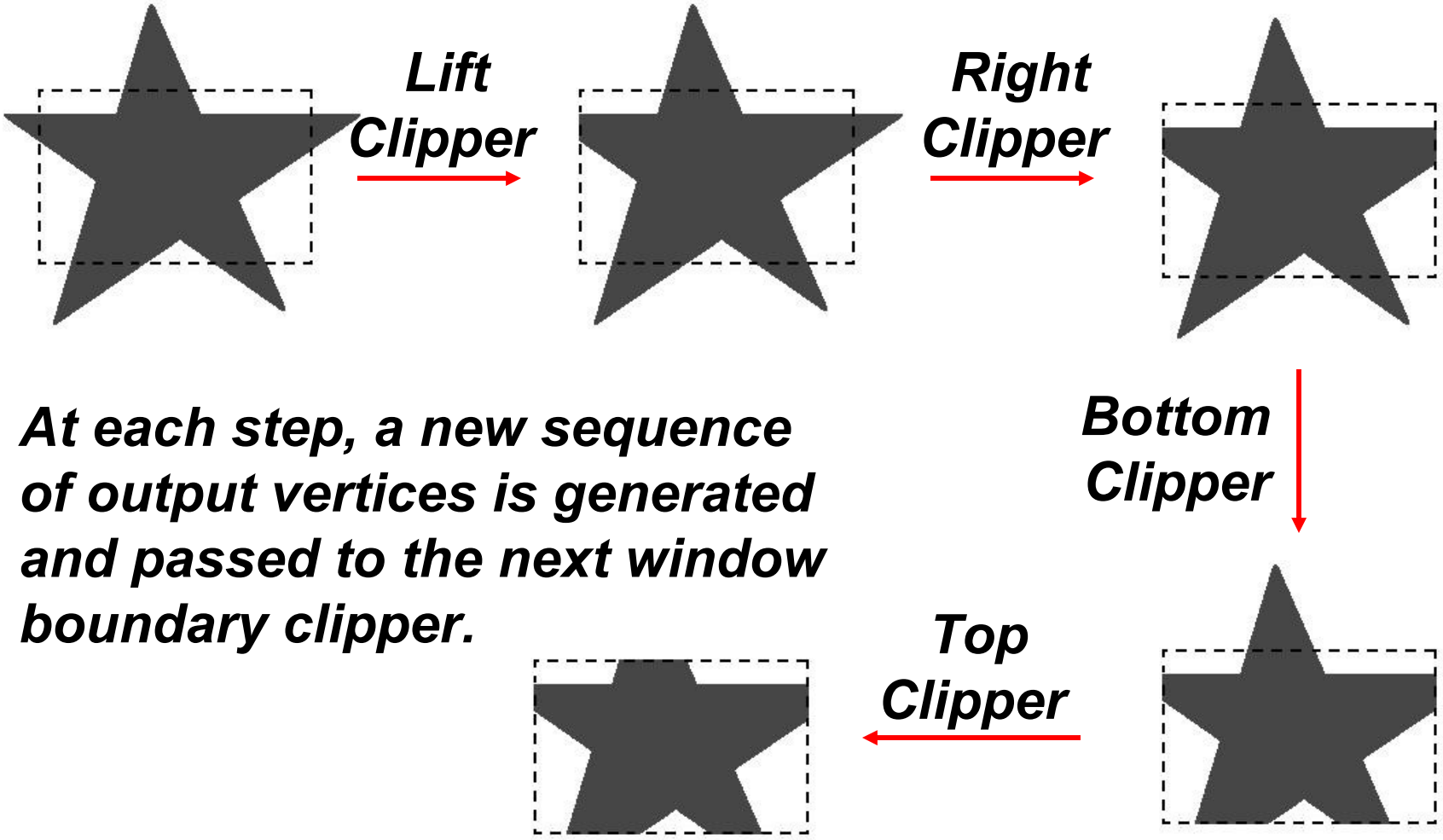


Sutherland-Hodgman Polygon Clipping

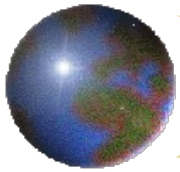
- *Clip a polygon by processing the polygon boundary against each window edge. (Left, Top, Bottom, Right).*
- *Apply four cases to process all polygon edges to produce sequence of vertices. This sequence of vertices will make a bounded area.*
- *Beginning with the initial set of polygon vertices, we could first clip the polygon against the left rectangle boundary to produce a new sequence of vertices.*
- *The new set of vertices could be successively passed to a right boundary clipper, a bottom boundary clipper, and a top boundary clipper.*



Sutherland-Hodgman Polygon Clipping



At each step, a new sequence of output vertices is generated and passed to the next window boundary clipper.



Sutherland-Hodgman Polygon Clipping

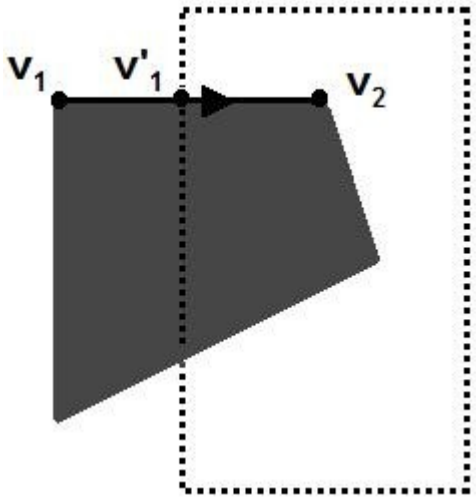
There are four possible cases when processing vertices in sequence around the perimeter of a polygon.

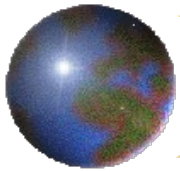
As each pair of adjacent polygon vertices is passed to a next window boundary clipper, we make the following tests:

Sutherland-Hodgman Polygon Clipping

1. If the first vertex is outside the window boundary and the second vertex is inside

Then , both the intersection point of the polygon edge with the window boundary and the second vertex are added to the output vertex list

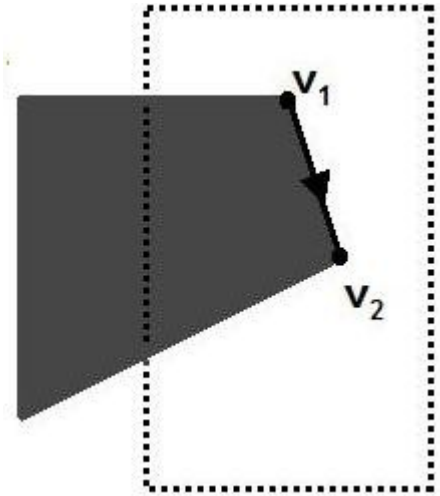




Sutherland-Hodgman Polygon Clipping

2. *If* both input vertices are *inside* the window boundary.

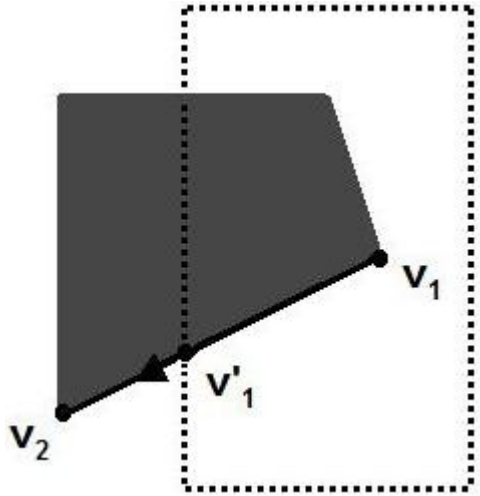
Then, only the *second vertex* is *added* to the *output vertex list*.

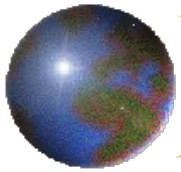


Sutherland-Hodgman Polygon Clipping

3. *If* the *first vertex* is *inside* the window boundary and the *second vertex* is *outside*.

Then, only the *edge intersection* with the window boundary is *added* to the *output vertex list*.

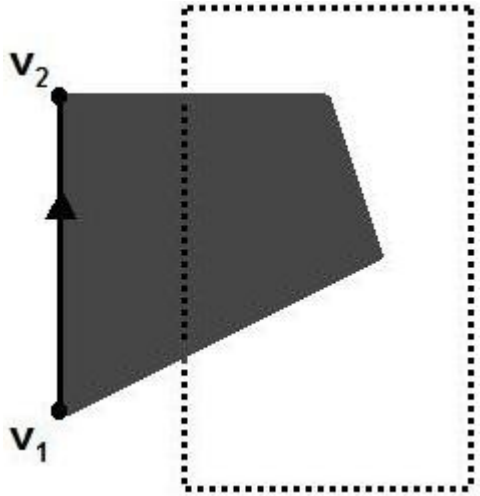




Sutherland-Hodgman Polygon Clipping

4. If both input vertices are outside the window boundary.

Then, nothing is added to the output vertex list.



Sutherland-Hodgman Polygon Clipping (Example)

We illustrate this algorithm by processing the area in figure against the left window boundary.

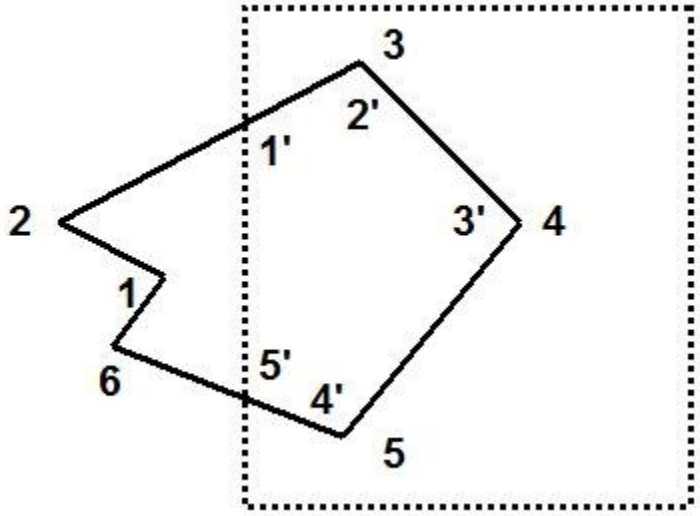
Vertices 1 and 2 are outside of the boundary.

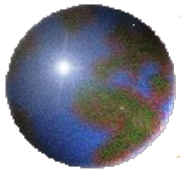
Vertex 3, which is inside, 1' and vertex 3 are saved.

Vertex 4 and 5 are inside, and they also saved.

Vertex 6 is outside, 5' is saved.

Using the five saved points, we would repeat the process for the next window boundary.

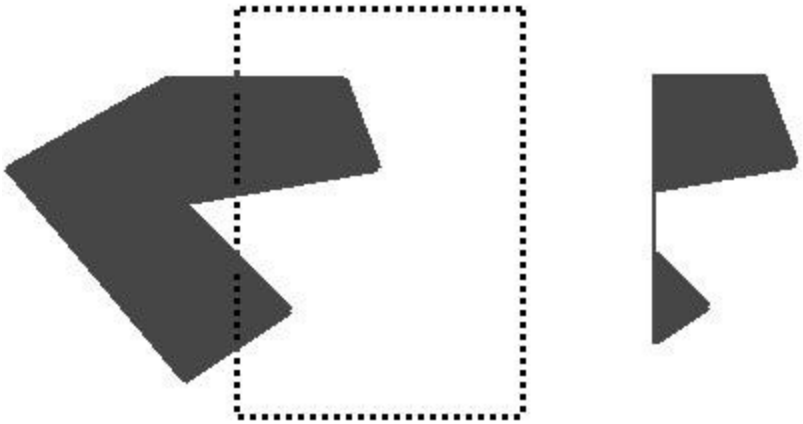


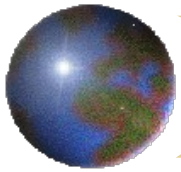


Sutherland-Hodgman Polygon Clipping

The Sutherland-Hodgman algorithm correctly clips convex polygons, but concave polygons may be displayed with extraneous lines as demonstrated in figure.

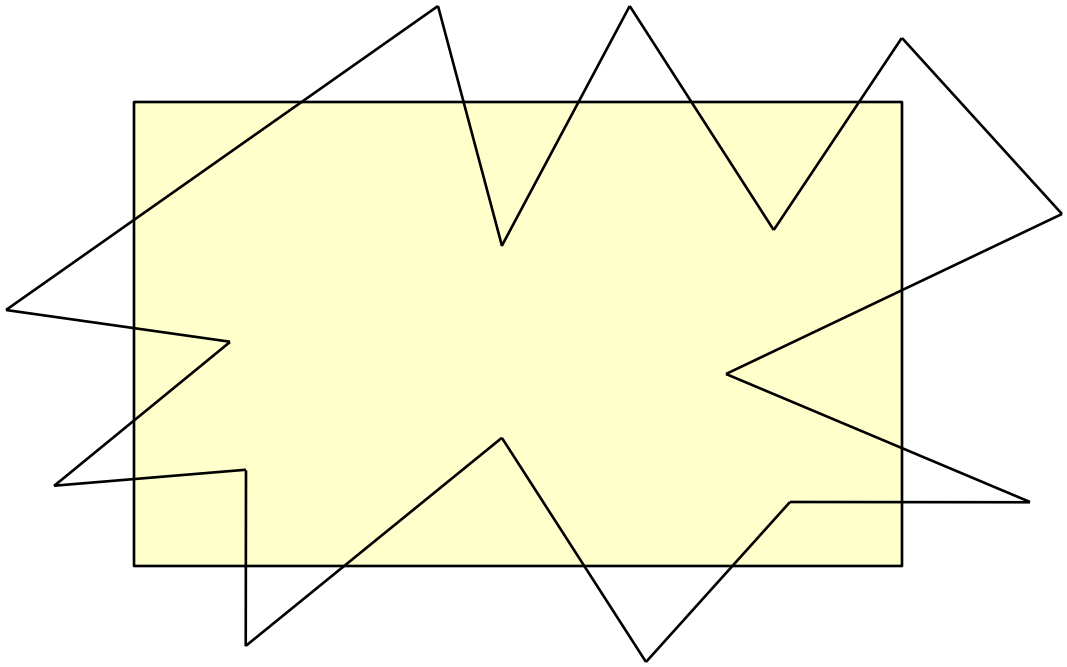
Since there is only one output vertex list, the last vertex in the list is always joined to the first vertex.

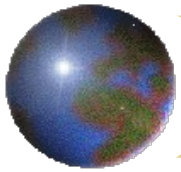




Sutherland-Hodgman Polygon Clipping

Complexity Of this algorithm will increase if number of edges of polygon increase. Algorithm has to calculate more number of intersection points over window boundary.





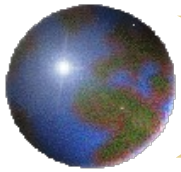
Weiler-Atherton Polygon Clipping

This algorithm was developed clip a fill area that is either a convex polygon or a concave polygon.

The basic idea of this algorithm is that instead of proceeding around the polygon edges as vertices are processed, we will follow the window boundaries.

The path we follow depends on:

- *polygon-processing direction (clockwise or counterclockwise)*
- *The pair of polygon vertices outside-to-inside or an inside-to-outside.*

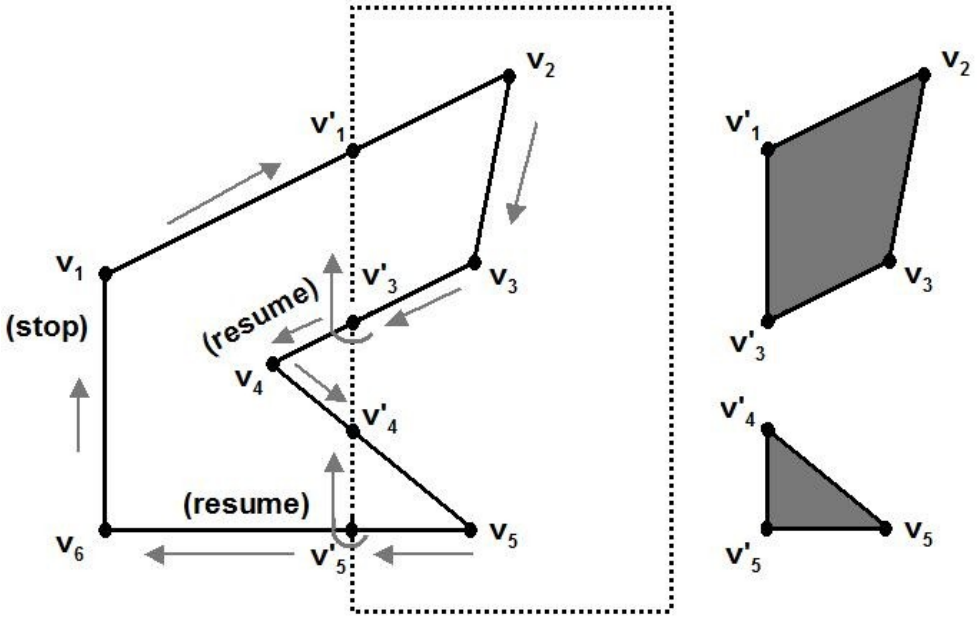


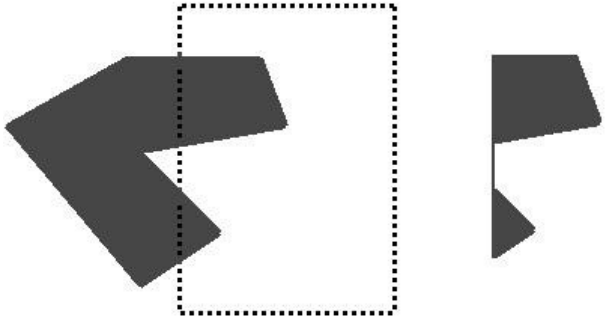
Weiler-Atherton Polygon Clipping

For clockwise processing of polygon vertices, we use the following rules:

- ***For an outside-to-inside pair of vertices, follow polygon boundaries.***
- ***For an inside-to-outside pair of vertices, follow window boundaries in a clockwise direction.***

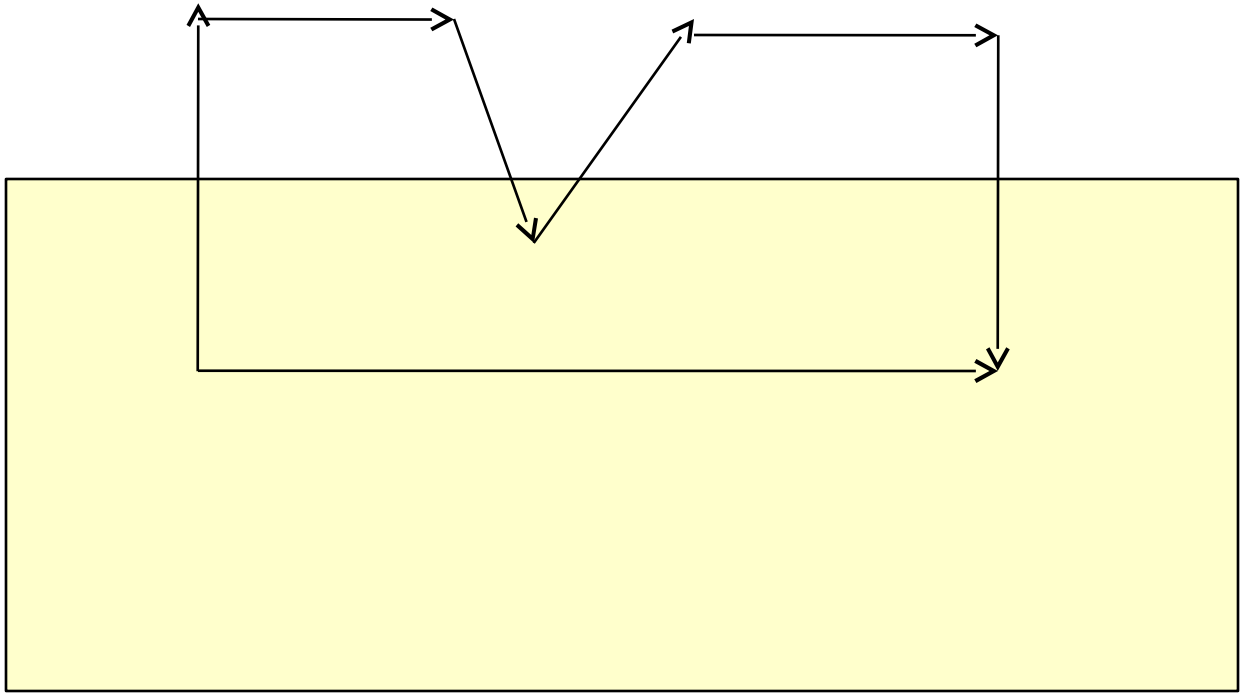
Weiler-Atherton Polygon Clipping *(Example)*





Clipped Polygon using Weiler-Atherton Polygon Clipping without connected component problem

Clipped Polygon using sutherland hogman algorithm with connected component problem



Thank You