Cohen-Sutherland

1001	1000	1010
0001	0000	0010
0101	0100	0110

Above,	Below,	Right,	Left
1000	0100	0010	0001

1. Compute outcode for each endpoint

2. OR outcode start & end

   $\emptyset \Rightarrow$ contained on screen $\Rightarrow$ BREAK

3. AND outcodes

   $\neq 0 \Rightarrow$ trivial reject as ~~one~~ atleast one point "stays"

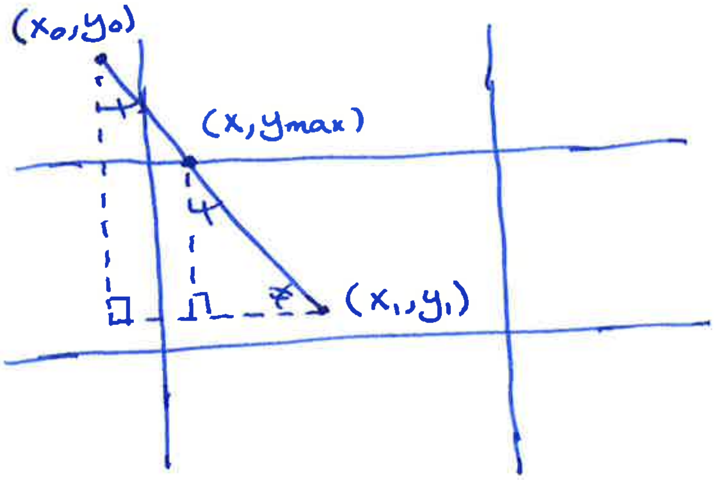
4. Pick point that is outside

   $\Rightarrow$ outcode $\neq 0$

5. Find intersection point

outcode AND Above

$\Rightarrow$ outside above, and the same for each.



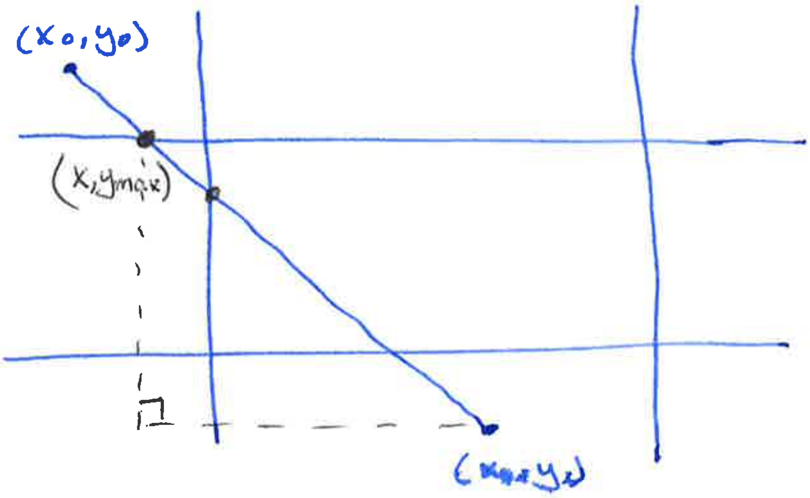
$(x_0, y_0) = 1001$

$1001 \& 1000 = 1000 \Rightarrow$ clipp to top plane

$$\frac{x_0 - x_1}{y_0 - y_1} = \frac{x - x_1}{y_{max} - y_1} \Rightarrow x = x_1 + (x_0 - x_1)\frac{y_{max} - y_1}{y_0 - y_1}$$

~~Check~~ (x_0, y_0) had outcode 1001 which means we still need to check 0001 $\Rightarrow$ left

$\Rightarrow x \geq x_{min}$ OK $\Rightarrow$ outcode $(x, y_{max}) = 0000$



$(1,0,01) \rightarrow (0100)$

- start with (x_0, y_0)

$1001 \,\&\, 1000 \Rightarrow$ ABOVE

$\Rightarrow (x, y_{max}) \qquad x = x_1 - (x_0 - x_1)\dfrac{y_{max} - y_1}{y_0 - y_1}$

$(0001\,(\hat{XOR})\,1000)\,\&\, 0001 \Rightarrow$ LEFT

$$\Rightarrow \frac{y_{max} - y_1}{x - x_1} = \frac{y - y_1}{x_{min} - x_1}$$

$$\Rightarrow y = y_1 + y_{max} - y_1 \cdot \frac{x_{min} - x_1}{x - x_1} =$$

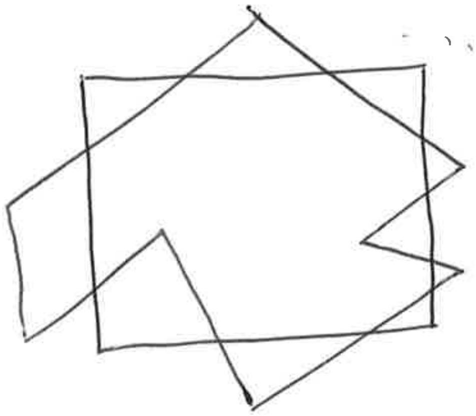
$$= y_1 + \frac{y_{max} - y_1}{x - x_1} \cdot (x_{min} - x_1) =$$

$$= y_1 + \underbrace{\frac{y_0 - y_1}{x_0 - x_1}}_{} (x_{min} - x_1)$$

slope only needs to be computed once.

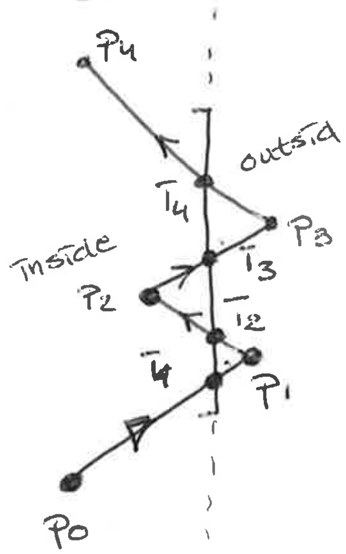
Sutherland-Hodgeman

Clipp any polygon against convex poly (screen rectangle)



1. Clipp each side in turn

For each clip-plane walk through each vertex in order



1. if P_0 & P_1 both inside add P_1 to list of vertices (P_1 becomes P_0)
2. if P_0 inside & P_1 outside add intersection
3. if P_0 & P_1 outside do nothing
4. if P_0 outside & P_1 inside add intersection

- case 1 ⇒ $\{I_1\}$
- case 2 ⇒ $\{I_1, I_2, P_2\}$
- case 1 ⇒ $\{I_1, I_2, P_2, I_3\}$
- case 2 ⇒ $\{I_1, I_2, P_2, I_3, I_4, P_4\}$

3D - clipping

We do perspective projection as

$u = \frac{x}{z} \cdot f$ which is the coordinate on the plane f along the z-direction.

projective geometry adds a redundant 4th coordinate

$\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$ ~ all points in the cartesian space have the last coordinate set to 1

⇒ take a general point in 3D space with a 4th coordinate

$\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$ what is the projection onto $z = f$ for this point $\begin{bmatrix} u \\ v \\ f \\ 1 \end{bmatrix}$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{f} & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ z/f \end{bmatrix}$$

— convert to 3D space ⇒ make $\omega = 1$

$$\Rightarrow \begin{bmatrix} x \cdot \frac{f}{z} \\ y \cdot \frac{f}{z} \\ f \\ 1 \end{bmatrix}$$

Take 3D vertices

0. "Scale world" such that near, far, side planes of view frustrum $= \pm 1$

1. Convert to homogenous coordinates

2. Write as projected points.

Clipping: